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Research Report 1522

The Application of Computers to Learning in the Comand and General Staff College: A Front End Analysis Study

Cognitive Engineering Design and Research Team (CEDAR)

May 1989

U.S. ARMY RESEARCH INSTITUTE
FOR THE BEHAVIORAL AND SOCIAL SCIENCES

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A front-end analysis was conducted on the expansion of the use of computers in instruction at the U.S. Army Command and General Staff College (CGSC). The knowledge, skills, and abilities (KSA) required of officers serving in staff positions are identified. Current curricula of the College are compared with this KSA and the College's performance in preparing officers for later assignments in staff positions is evaluated. Opportunities to improve instructions through further applications of computers to learning (ACL) are identified, and steps in a program for exploiting those opportunities are described. Recommendations concerning initiation of the program, including the immediate follow-on effort required, are made.

This report presents only the findings and recommendations of the front-end analysis. Supplementary reports are separately bound. The reports all have the beginning title, Application of Computers to Learning in the Command and General Staff College. The follow-on headings for the other individual reports are as follows:

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CGSC Analysis
Analysis of Staff Officer Knowledge, Skills, and Abilities
Assessment of Computers in Education at Various Institutions
Technology Assessment
Assessment of Computer Literacy in CGSC
Analysis of Institutional and Financial Constraints
Army Command and Control Concepts Study
Comparison of Knowledge, Skills, and Abilities to CGSC Learning Objectives
Identification of Computer Opportunities

Research Report 1522

The Application of Computers to Learning in the Comand and General Staff College: A Front End Analysis Study

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Human Factors in Training and
Operational Effectiveness

FOREWORD

The Command and General Staff College (CGSC) prepares military officers to perform coordinating staff functions and to assume command positions at brigade and higher echelons. The Deputy Commandant of CGSC requested a front-end analysis to determine how emerging computer technology could be used at CGSC to close the gap between classroom and "real" experience. The Cognitive Engineering Design and Research team of the Los Alamos National Laboratory was recruited to conduct the analysis in cooperation with the Fort Leavenworth Field Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI). The goals, procedures, findings, and recommendations of the resulting study are presented in this report. Additional detail is provided in separately bound reports. Collectively, this information is the initial step in defining requirements for the implementation of instructional computer technology in CGSC.

This effort was supported under Research Task 144, "Advanced Technology for Command and Staff Operations." The work was performed under the long-standing memorandum of understanding between ARI and CGSC entitled, "Research and Evaluation Program for Present and Future Command and Control Requirements and Operations, 31 May 1983." Status briefings were provided to the CGSC throughout the project with final briefings presented to the Assistant Deputy Commandant and CGSC Directors on 14 August 1987 and to MG Gordon R. Sullivan, Deputy Commandant, on 13 November 1987. The results of this effort have been adopted by CGSC and, as a result, planning for the implementation of these recommendations has occurred.

EDGAR M. JOHNSON
Technical Director

PREFACE

This report concerns one of the Army's most important institutions, the U.S. Army Command and General Staff College (CGSC), which is the fount of tactical and operational knowledge for Army forces. This knowledge is a major force multiplier that holds potential enemies at bay, enhances deterrence, and thus moves us closer to a lasting peace.

The CGSC is a very complex organization that is undergoing major change brought about by computer technology. Further, the pace and scope of the change is faster and broader than in the past. The Army, educational technology, computer technology, and tactical doctrine are changing concurrently. CGSC must not only keep up but must also assist in the process because the College is an instrument of change for the Army. The College prescribes how the Army will fight and how its staff will function.

The Los Alamos project team held this view of the CGSC. The actions to be initiated, based on this report, are far reaching because they will influence the quality of our Army in the years to come. The study was conducted in this spirit.

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THE APPLICATION OF COMPUTERS TO LEARNING IN THE COMMAND AND GENERAL STAFF COLLEGE: A FRONT END ANALYSIS STUDY

EXECUTIVE SUMMARY

Requirement:

The problem statement for this study was to determine how best to introduce computers into the Command and General Staff College (CGSC) curriculum. While the statement is simple, it was complex in execution and also embraced other CGSC missions. This Front End Analysis identifies how to begin, but much work remains to realize the advantages of computers in CGSC.

The limited time available to the project team precluded gaining familiarity with the courses taught at CGSC by observing classroom instruction; course programs of instruction were used as definitive descriptions of courses, subcourses, and learning objectives.

Because no official listing of the knowledge, skills, and abilities (KSA) needed by coordinating staff officers of operational and tactical commands exists, they were inferred from the list of the duties and responsibilities of those staff officers in Field Manual 101-5, Staff Organization and Operations (FM 101-5) (Dept. of the Army, 1984) for the purpose of comparing them with the content of CGSC courses.

The current state of CGSC computer acquisition planning allows for input from this project at the implementation phase.

Recommendations for expanding the use of computers at CGSC must acknowledge constraints arising from many organizational, physical, and budgetary realities, including the past success of staff group instruction as the principal method used.

Procedure:

A study plan described in detail in the main body of this report was developed. Essential elements included the examination of the CGSC curriculum; study of staff officer functions to identify KSA required for their positions; and comparison of the requirements with what is taught. From this comparison and after development of a taxonomy for the applications of computers to learning (ACL), opportunities were identified. Additionally, the status of the College was assessed and compared with the opportunities. From this comparison, priorities for the College with respect to the introduction of computers and recommended actions were derived. While not initially intended, a doctrinal issue

with regard to staff officer responsibilities was identified and is reported.

Findings:

The project team continually had to consider priorities among the functions of CGSC. The following list of priorities was used and is recommended for adoption. A more complete discussion can be found in the Priorities and Recommendations section at the end of this report.

Priorities for the Introduction of Computers into CGSC

- Resident instruction (excluding collective training).
- Nonresident instruction.
- Other CGSC activities related to distribution of information (for example, Military Review).
- Collective training.

The project team also arrived at five major conclusions:

1. A single focal point for the introduction of computers into the CGSC curriculum needs to be established. This focal point also should be responsible for identifying and integrating CGSC requirements with the DOIM (Director of Information Management). DACTS (Department of Automated Command and Training Systems) should be this focal point, and the organization should be augmented accordingly.

2. Specifications for baseline standard hardware/software and networking should be written based on functional requirements, which are defined here as the goals and mission elements that would be supported by integrating computers into the College. These requirements include establishing learning centers in which students have access to computers and a library of software enabling them to do word processing, to work with spreadsheets and databases, to study courseware independently, and to seek assistance from resident advisers. The equipment should be procured and used as soon as possible. Networking includes the capability to open the College to the officer corps at large.

3. Initially, hardware and software should be provided to the staff and faculty to assist in administrative functions related to teaching (and implicitly supporting doctrine development) to effect faculty familiarity and expertise for the eventual widespread use of computers in the classroom.

4. To [illegible]ance in-house expertise regarding computer technology and preparation of specifications, development of courseware should begin immediately on a small scale.

5. Control of operations should be formally recognized as a fifth principal staff function, ranking with providing information, making estimates, making recommendations, and preparing plans and orders. FM 101-5 refers to supervising the execution of decisions as one of five common functions on which staff activities are centered, but it fails to identify this function as coequal with the other four listed with an explicit description. Supervision is listed under the explicit description of the function of preparing plans and orders. The emphasis given to controlling operations in progress in FM 101-5 is one factor strongly suggesting that a fifth principal staff function ought to be specifically identified, recognizing that exercising control of operations through an operations center and other means of staff supervision in conformance with command guidance is its essence.

No conclusions can be drawn with respect to the Battle Command Training Program (BCTP) because of its current state of development. However, as BCTP progresses, every opportunity to exploit its capabilities for individual training should be seized. With regard to Classroom 2, the requirement for considering BCTP in all development efforts and as a major influence on the high-tech classroom seems to be implied.

Implicit in the major findings are certain actions that should be taken. These actions are expressed in the following recommendations (affecting the priorities or activities as indicated).

General Recommendations Regarding the College

- Establish the DACTS as the focal point for all College planning for the use of computers. Establish TDA (Table of Distribution and Allowance) positions according to the organization depicted in figure 7 on page 52. (Affects all priorities.)

- Enhance staff and faculty productivity and begin the automation of the College by providing personal computers (PCs) with a standard software package. A recommended base hardware/software package is shown in Table X on page 68. (Affects all priorities.)

- Supplement the standard PC with additional software and hardware as required for specific functions in specific organizational elements. For example, desktop publishing is useful in many parts of the College but is not universally needed. (Affects all priorities.)

- Develop functional requirements for all near-term computer initiatives to include networking, which encompasses both internal and external access as shown in figure 8 on page 58. (Affects all priorities.)

Recommendations Concerning Instruction and Learning

- Establish learning centers equipped with the standard PC (see Table XI on page 69). These systems must have potential for growth, being able to accept expansion units that permit other ACL implementations. Additionally, these centers must support staff and faculty training concurrent with the issue of PCs. (Primarily affects resident instruction.)

- Make the standard PC available for purchase. (Affects resident instruction and staff and faculty productivity.)

- Place emphasis on opening CGSC to nonresident students and the officer corps in general through networking. Additional studies are not needed on this point. The specifications of the School of Corresponding Studies (SOCS) for implementing the initial "electronic university" should be developed now. Additional studies about SOCS after networking can continue. (Affects the outside view of the College and nonresident instruction.)

- Develop a computer-assisted instruction (CAI) course that demonstrates the state of the art to the faculty and provides them with an appreciation of what can be done. (Primarily affects resident instruction.)

- Support research or request U.S. Army Research Institute for the Behavioral and Social Sciences to support research into gaming as it applies to the College. A successful game could be used locally as well as on line by nonresident students. The School of Advanced Military Studies (SAMS) should participate in the design process for the game. (See expanded discussion of gaming in Identification of Computer Opportunities, Task G report.) (Affects all instruction.)

- Begin planning for the "high-tech" classroom to include "one each" acquisitions for experimentation. (Affects resident instruction.)

- Develop the MAPP* and COTES** software as standalone tools for use on the standard PC shown in Table XI. (Affects all instruction, assuming SOCS networking.)

- Formally establish a Command and General Staff School (CGSS) or identify a single assistant to the Deputy Commandant as responsible for the instructional content of the Command and General Staff Officers Course (CGSOC) for both resident and nonresident versions. (Affects CGSOC by bringing resident and nonresident instruction closer into line.)

- Conduct a zero-base review of the curriculum to validate the need for each lesson and identify factors affecting the stability of content. This recommendation also embraces a review of core versus elective courses in CGSOC because of the manpower devoted to maintaining electives. (Affects all.)

A Recommendation Regarding Doctrine

- Establish a fifth coordinating staff officer function of controlling. In addition to describing more accurately what a staff officer does, it explicitly establishes the need for training vehicles to teach the controlling function. In turn, the need for developing simulations for individual and collective training as well as gaming is supported. (Affects both doctrine and instruction.)

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*MAPP (Military Applications Program Package) is a set of 15 or more software tools developed by CAS^3 (Combined Arms and Services Staff School) personnel to support the CAS^3 Phase II Course. Programs available include Decision Matrix, Movement Planning, Statistics, Petroleum Status, and others. The programs are self-documented on floppy discs that run on the Wyse PC microcomputer or on an IBM PC compatible.

**COTES (Combat Orders Training and Evaluation System) is an interactive, computer-assisted instructional system, designed to be used for training purposes at the U.S. Army CGSC. The overall objective of COTES is to aid the CGSC student in the time-consuming tasks inherent to the decision-making process. COTES provides automated methods for collecting, analyzing, and arranging data for input into orders, appendixes, annexes, and reports. COTES is a comprehensive decision-aids package that provides support for learning and mastering the skills required to create these documents, while at the same time showing the student the capabilities of computers and computer technology.

Utilization of Findings:

This research will be used to guide implementation of a program to expand the use of computers in CGSC instruction. The findings identify the initial steps to be taken in the implementation and describe the measures that should be initiated now in preparation for a longer term payoff in exploiting technological advances in ACL. In particular, the next phase of follow-on effort is described, together with recommendations concerning the agencies that should be charged with conducting it.

THE APPLICATION OF COMPUTERS TO LEARNING IN THE COMMAND AND GENERAL STAFF COLLEGE: A FRONT END ANALYSIS STUDY

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THE APPLICATION OF COMPUTERS TO LEARNING IN THE COMMAND AND GENERAL STAFF COLLEGE: A FRONT END ANALYSIS STUDY

A VIEW OF THE FUTURE

The most valuable resources of the CGSC are the instructors who prepare and present class materials. They are charged with the development of officers who will lead the Army into the future. There is no standard by which to measure the success of their efforts other than the security of the nation. However, these instructors should avail themselves of tools that will enhance the effectiveness of their instruction.

In parallel with the teaching mission, the staff and faculty of CGSC have responsibility for the development of doctrine. This responsibility is no less important than the training of those who will execute the doctrine and further its development. Taken together, these responsibilities make CGSC the preeminent tactical college of the U.S. Army and place it in a position of leadership within the Army school system.

Initially, this study was intended to determine the most effective way to introduce computers into the curricula of CGSC, with special emphasis on the role of simulation. It was to be a Front End Analysis as part of the instructional system development process. Therefore, the project team examined the curricula and the KSA of staff officers. However, as the study progressed, it became evident that the critical issue was how to use computers to assist the instructor in executing his responsibilities both inside and outside of the classroom.

This report examines the issue of how to use computers most effectively within CGSC to enhance the instructional process in the future. The project team found the educational content and processes at the College to be quite sound. However, CGSC can further exploit computer technology to its advantage.

What does the future hold for CGSC? Every person who has been associated with CGSC has a different perspective of the future College. These views will have one fact in common: They will all be wrong in detail. The College is guided by periodically changing leadership within a dynamic Army and influenced by new technology being introduced at an exponential rate. The decisions made today will be modified to adapt to the new environments and requirements. Nevertheless, a vision of the future is necessary if one is to prepare for it.

Four primary factors will influence how the College will function in the future:

1. The KSA that both instructors and students will bring to the College.

2. Advances in educational technology to include cognitive science, our understanding of how people learn, and the application of artificial intelligence (AI) and its paradigms to training and education.

3. The continued growth of the information age, comprising the collection and processing of information, better understanding of the decision process, and improved use of available information in the higher cognitive levels of assessment, synthesis, and evaluation.

4. The continuing need to develop leaders who can anticipate and adapt, recognizing that the flexible commander most likely will win the first battle.

Future instructors and students will be products of a society in which the computer is a common tool. Today, cadets at the U.S. Military Academy are required to purchase a personal computer, and students at many colleges and universities are required to have access to a PC. Within 10 years, many of these students will be entering CAS^3 (Combined Arms and Services Staff School). They will be at ease with this tool and its ability to assist in problem solving as well as its capacity for functioning as a learning aid. Further, they will recognize that computers can emulate one another and will be able to conceptually transfer functions from system to system.

In 1981, IBM introduced its PC. This event was significant in educational technology for two reasons. First, it heralded that the PC was here to stay, while opening up the market to third party vendors to develop and sell new products. IBM released an open architecture system that facilitated the use of new devices, such as a videodisc and digital audio. Second, it permitted severing the umbilical cord to the mainframe computer for the use of a PC as an instructional tool because the standalone machine now has sufficient capacity. In the ensuing years, the capacity of the PC has continued to grow, doubling at a rate of once every three years.

During the same period, the discipline of AI has blossomed. While AI applications are not commonplace and remain very expensive to develop, the growth of the field has significantly affected how problems and learning are considered. There is an increased awareness of the differences between the novice and the expert, including how they organize and use knowledge.

In turn, there has been growth and new promise of significant advances in the area of how people learn. These insights are yielding better techniques for teaching, many of which will capture the power of available technologies. And, as a corollary, they will establish that earlier techniques should not be discarded just because they are old.

It should not be expected, however, that improvements in methods of instruction will lead to a definitive identification of the key elements of information needed by commanders for making correct decisions in conflict, nor will those improvements serve to identify the traits that great captains of the future will have in common.

Instead, the military is faced with a battlefield of ever increasing tempo and is striving to provide their leaders with all available information so that they can have what they need. The conclusion is that the future commander, aided by his staff, will have to process and judge greater quantities of information to identify the essential elements in a shorter period of time.

Finally, if and when future leaders enter combat, their units as well as the enemy will use and will be supported by weapons not previously used in battle. While the project team made an attempt to anticipate the impact of new technology on the combat dynamic, the future battlefield will not be fully anticipated or predicted. Hence, our future leaders will have to synthesize new knowledge on the spot and adapt to the context of organizational doctrine. They will have to use their equipment, units, and procedures in a flexible manner, creating new tactical doctrine to meet the exigencies of the situation.

Translating these factors into a future view of CGSC suggests an institution in which the following factors are in place:

- Instructors are assisted in requisite menial tasks through automation, thereby affording them more time to work with students and develop better course material.
- Instructors are assisted in the classroom by computers, freeing them from less demanding tasks to concentrate on higher levels of learning.
- Students have greater opportunity to practice staff skills that represent the organization and procedural doctrine through the use of computers that emulate field equipment and provide intelligent monitoring of student performance.
- Students (as well as staff and faculty) have the resident computer tools to explore battlefield dynamics without the tedium of attendant staff detail--that is, a computer simulation that allows them to play the role of commanders while the computer functions as their staff as well as the arbiters of battle results.
- Staff, faculty, and students use research databases, such as Combined Arms Research Library (CARL), with computer assistance in the search function.
- Staff, faculty, and students are assisted in personal productivity through the use of computers.
- The resources of CGSC are available to greater numbers of officers worldwide through computer-based communication networks, permitting access to both simulations and research sources.
- Improved nonresident instruction is possible through increased efficiency, improved quality of instruction, and easy student access to faculty.
- CGSC is the leader in the development of tactical combat models for individual learning and personal research.

An old proverb says that a journey of a thousand miles begins with a single step. This report deals with that step.

INTRODUCTION

How to Read This Report

This report has been compiled to meet the needs of a variety of users. If one reads the report from beginning to end, it will appear redundant. The report's structure has three levels of detail regarding the presentation of data and the rationale leading to the conclusions.

- **Executive Summary:** This section summarizes the assumptions, methodology, ACL, priorities, major findings, and recommendations of the study with little supporting rationale.
- **Omnibus Report:** Exclusive of the Executive Summary, this portion presents a philosophical view of the future and summaries of detailed analyses contained in standalone task reports as required to logically develop the overall findings. The Discussion section presents the integrating rationale of the study, and the Priorities and Recommendations section presents a recommended course of action.
- **The Standalone Task Reports:** These standalone documents present the detailed data and analyses of the separate tasks of the study.

If the reader has an interest beyond the findings, he should skip the executive summary and read the omnibus report, referring to the standalone task reports as required. Detailed reading/study of the task reports is recommended for those individuals needing the data and analyses they contain.

Goals

This study was initiated by the Fort Leavenworth Field Unit of the Army Research Institute to assist the CGSC to determine how best to introduce computer technology and, in particular, computer-based battle simulation into the curricula of the College. The original goal was based upon the vision of the Deputy Commandant at that time regarding the use of computers to support learning by permitting students in the College to try various tactical approaches to battle scenarios, thereby gaining insight into battle dynamics.

Conceptually, the original plan envisioned examining the KSA required of graduates, comparing them with the curricula of the schools within the College, looking at the future to ensure the continued validity of the KSA, and deducing from this data how battlefield simulations would improve the educational process.

Through initial discussions with representatives of the College and ARI, the project team determined that a broader problem statement should be examined. Hence, the study began with the following formal problem statement:

> With rationale based upon the Front End Analysis, the project team intends to make recommendations on how the CGSC can best integrate computers and their applications into the curricula.

Tasks

The plan for the study is shown below:

A. CGSC Analysis
B. Analysis of Staff Officer Knowledge, Skills, and Abilities
C. Assessment of Technology and Computer Literacy
D. Analysis of Institutional and Financial Constraints
E. Army Command and Control Concepts Study
F. Comparison of Knowledge, Skills, and Abilities to CGSC Learning Objectives
G. Identification of Computer Opportunities
H. Identification of Candidate Applications
I. Assessment of Impact of Candidates
J. Implementation Scheme Development
K. Recommendations
L. Final Report

The subject of each task was as follows:

Task A. Analyze the CGSC curricula with particular attention to the learning objectives, cognitive levels of the lessons, organizational structure, and computer usage.

Task B. Analyze the KSA required for the effective performance of command and staff tasks of Army field grade officers. Assign appropriate levels to each set of KSA according to Bloom's Taxonomy.

Task C. Assess computers in education and technology and computer literacy at CGSC.

C-1. Assess the current state of implementation of computers in education at universities and research centers to establish a benchmark for determining the status at CGSC.
C-2. Assess hardware and software by studying the current computer technology for educational applications.
C-3. Assess the current level of computer literacy in the staff, faculty, and student populations at the CGSC through the administration of a questionnaire.

Task D. Analyze and determine if there are existing or programmed (one- to five-year) institutional and financial constraints that would seriously impact the successful implementation of computers into the CGSC curricula.

Task E. Identify and define characteristics of staff officers and tasks required of them. Determine characteristics of the battlefield in 5 to 10 years and computer usage in the Army of the future.

Task F. Draw appropriate conclusions regarding the performance of CGSC in training staff officers by comparing the KSA required for the performance of command and staff tasks within CGSC curricula.

Task G. Identify potential uses of computers within CGSC. (Initially done without constraint to stimulate creativity in the analysis.)

Task H. Identify candidate applications of computers, considering technological and resource constraints that currently exist within the College.

Task I. Prioritize the impact and implementation of the candidate applications with respect to return on the investment.

Task J. Within the time available for the study and the eventual magnitude of its scope, develop an implementation scheme by which the College can move toward computerization.

Task K. Through the presentation of a draft report and a briefing for the Deputy Commandant, make recommendations and obtain concurrence with the findings of this study.

Task L. Complete the study and submit the final report.

Background

The CGSC has five separate programs, four of which are administered by clearly established schools as shown below:

CGSS: Command and General Staff School, which administers the Command and General Staff Officer Course (Note that the CGSS is not established in the sense of CAS^3, SOCS, SAMS, and SPD.)

CAS^3: Combined Arms and Services Staff School

SOCS: School of Corresponding Studies
(SOCS administers extension courses for the CGSOC and CAS^3 Phase I.)

SAMS: School of Advanced Military Studies

SPD: School for Professional Development

To limit the scope of the study, the project team decided not to examine SPD in detail. The limited time available to the project team precluded detailed study of the multiple, short, and special purpose courses taught in SPD. In the case of SAMS, its limited enrollment of 52 students per year immediately caused us to question the cost-to-benefit ratio that would result from near-term major investment. However, both of these schools have many of the same administrative and functional requirements as the rest of the College and in this respect were fully considered.

Early in the study, the project team needed to determine the mission of the College and the objectives of the schools and courses in accomplishing the mission. An understanding and definition of these missions and objectives were essential to the analysis function. The central issue was the balance between emphasis on command and staff.

SAMS is a special case because it focuses on the in-depth study of tactics and battle dynamics. These subjects clearly support the command function by developing tacticians. In its own way, the school offers specialist training that develops a corps of officers to advise commanders and develop future doctrine. Of course, this training does not preclude SAMS graduates from commanding the Army's largest units.

In the case of CGSOC, CAS^3, and SOCS, the courses presented focus on staff functions, procedures, analysis, and recommendations. As far as the commanders' understanding of the staff and the command and staff relationship is concerned, the instruction stresses the role of the staff. Upon graduation, graduates are not expected to be commanders of battalions, brigades, or divisions without additional apprenticeship on staffs. Later in this report, the project team will show that staff officers do exercise certain command functions "for the commander" in accomplishing their tasks.

From these considerations, the following mission statements/objectives were constructed for this study:

CGSC: The mission of the U.S. Army Command and General Staff College is twofold:

- To develop leaders who will train and fight units at the tactical and operational levels.
- To develop Combined Arms Doctrine and assist in its promulgation.

CGSS: The Regular Course includes the regular Resident Course (1-250-C2), the 19-week Reserve Components Course (1-250-C4), the USARF School Course (1-250-C3), and the Correspondence Course (1-250-C3) and prepares officers for duty as field grade commanders and principal staff officers at division and higher echelons.

CAS^3: The Staff Officers Course trains officers in the Active and Reserve Components to function as staff officers at battalion, brigade and division levels.

SOCS: This school administers the CGSC corresponding studies program.

SAMS: The Advanced Military Studies Program provides 48 CGSOC Regular Course students the opportunity to spend an additional year of concentrated study in the conduct of war at the tactical and operational levels.

SPD: This school organizes and administers professional development courses at CGSC for Active and Reserve Component officers, warrant officers, noncommissioned officers, and civilians (U.S. Army CGSC, 1986).

Organization of the Report

The remainder of this omnibus report contains four sections:

- Main Findings of the Project
- Summaries of Component Tasks
- Discussion
- Priorities and Recommendations

The Main Findings section details the priorities for the introduction of computers into CGSC and summarizes the project team's five major findings of the study. Other findings of importance were included in standalone task reports when they did not impact on the overall objectives of the study.

In the Summaries of Component Tasks section, Tasks A through G will be summarized by briefly describing the methodology used, stating the principal findings and relating these findings to the total study. For convenience, the findings will be listed without rationale or implications in separate tables. Supplementing this report are extensive standalone documents containing detailed analyses of Tasks A through G.

The Discussion section will document the integrated analysis portion of the study. Essentially, it will document Task H and beyond, and this section forms the basis for the recommended course of action contained in the Priorities and Recommendation section.

A final comment is in order before continuing. The structure of tasks and the flow chart contained in Fig. 1 suggest that the study was straightforward and that the elements of it are truly separable. Such was not the case. The CGSC, its organization, and its curricula have evolved over many years. Its various elements and activities have many interdependences, often leading to confusion. Nevertheless, the College is effective, suggesting that its task is indeed complex. Yet, there must be an order to the presentation of findings and the development of results. For this reason, the original structure of the study will be followed in this report.

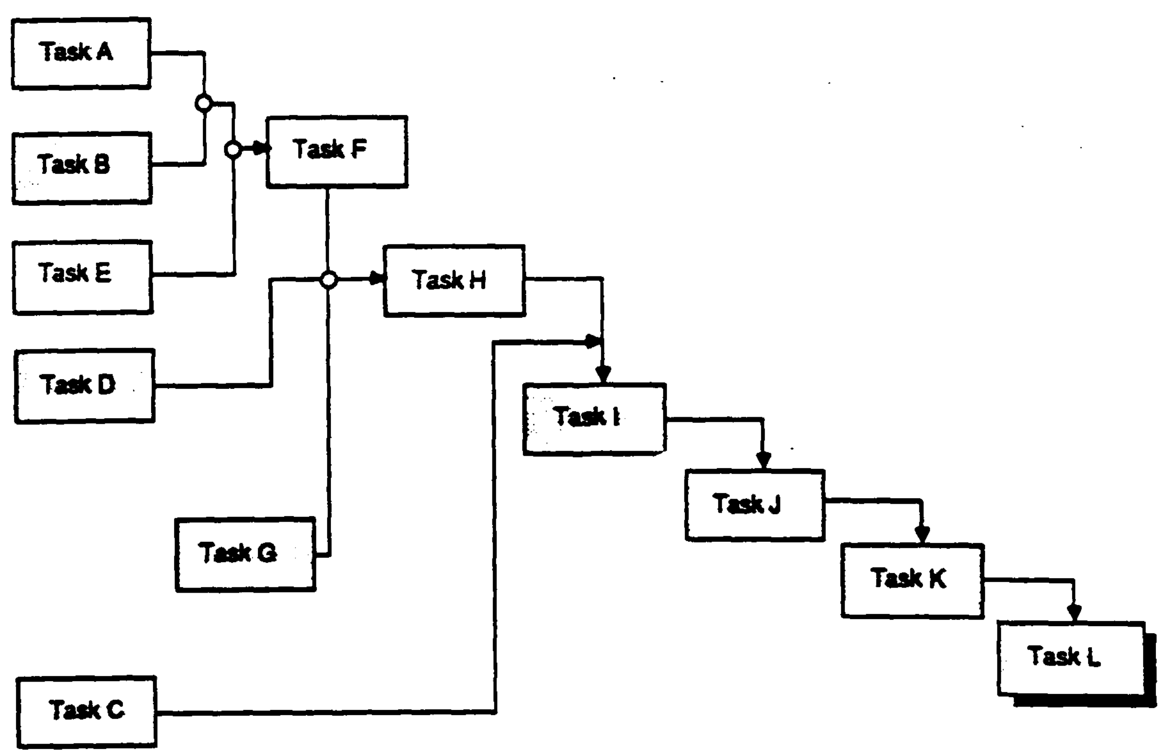

Fig. 1. Structure of the tasks and flow chart.

MAIN FINDINGS

Throughout the study, the project team continually had to consider priorities among the functions of CGSC. The following list of priorities was used by the project team and is recommended for adoption with regard to introducing computers into the learning process. Note that these priorities are related to the Applications of Computers to Learning described on page 46 of this report. A more complete discussion can be found in the Priorities and Recommendations section at the end of this report.

Priorities for the Introduction of Computers into CGSC

- Resident instruction (excluding collective training).
- Nonresident instruction.
- Doctrine development.
- Other CGSC activities related to distribution of information (for example, Military Review).
- Collective training.

The project team also arrived at five major findings:

1. A single focal point for the introduction of computers into the CGSC curricula needs to be established. This focal point should also be responsible for the identification and integration of CGSC requirements with the DOIM. This focal point should be the DACTS, and the organization should be augmented accordingly.

2. Specifications for baseline, standard hardware/software, and networking should be extended based on functional requirements and the equipment procured and used as soon as possible. Networking includes the capability to open the College to the officer corps at large.

3. Initially, hardware and software should be provided to the staff and faculty to assist in administrative functions related to teaching (and implicitly supporting doctrine development) to effect faculty familiarity and expertise for the eventual widespread use of computers in the classroom.

4. To develop in-house expertise regarding the technology and preparation of specifications, courseware development should begin on a small scale immediately. A good example of an immediate CAI application that should be developed is in the P118 subcourse in the CGSOC. We chose the P118 subcourse because this subcourse presents the most important and longest part of tactics taught in the core curriculum and because several parts of P118 could be taught using CAI. CAI software to provide the refresher in battalion and brigade level operations and to teach the Soviet Army organization, equipment, doctrine, and tactics could easily be developed into a set of CAI software packages that would insure uniformly high-quality education of the CGSOC officers.

5. Control of operations should be formally recognized as a fifth principal staff function, ranking with providing information, making estimates, making recommendations, and preparing plans and orders. For reasons that were obscure to the project team, FM 101-5 refers to supervising the execution of decisions as one of five common functions on which staff activities are centered, but it fails to identify this function as coequal with the other four that are listed with an explicit description. Supervision is listed under the explicit description of the function of preparing plans and orders. Whatever the reason for this treatment of the subject of staff supervision, the emphasis given to controlling operations in progress in FM 101-5 is one factor strongly suggesting that a fifth principal staff function ought to be specifically identified in staff doctrine, recognizing that exercising control of operations through an operations center and other means of staff supervision in conformance with command guidance is its essence.

SUMMARIES OF COMPONENT TASKS

Task A (CGSC Analysis) Summary

Task A Description

The goal of Task A was to analyze the CGSC curricula in terms of organizational structure and cognitive levels, with particular emphasis on computer usage in the College. This analysis contributed to the Front End Analysis study of determining where computers can best be used within the College curricula by providing baseline data on the College.

Methodology

A significant amount of time spent on this task involved gathering raw data from the College and analyzing that data in terms of what is relevant to the Front End Analysis and to the use of computers in CGSC. The College provided us with the Programs of Instruction (POI), the College catalog, the nonresident instruction catalog, student material for both CAS^3 and CGSOC Nonresident Courses, and other documents. Additionally, conversations were held with College faculty, staff, and students to clarify issues, get more information, and determine opinions that would be relevant to the project.

To effectively use some of the data on the schools that were gathered from the College, a database was established using a database management system called REFLEX (1985). Other data were analyzed in tabular and graphical form. Based on the information that the College and its personnel provided, ideas in the form of hypotheses were generated. These hypotheses were tested to determine whether the data would support them and to determine their relevance to the project.

Results

Cognitive level analysis. Using Bloom's Taxonomy (Bloom, 1956), an analysis was made of the cognitive levels taught for CAS^3 Phase I, CAS^3 Phase II, CGSOC Core Curricula, CGSOC Electives, and SAMS. There are six levels in Bloom's Taxonomy as shown below. Because the complexity of mental activity increases dramatically as one progresses from one level to the next, the project team chose the following weighting scheme to quantify the results of the cognitive level analysis:

Cognitive Level	Weighting
Knowledge (K)	1
Comprehension (C)	2
Application (Ap)	4
Analysis (An)	8
Synthesis (S)	16
Evaluation (E)	32

Table I shows the number of terminal objectives (as specified by the course authors) and the weighted cognitive levels for the courses shown. The weighted average cognitive level for CAS3 Phase I is 1.68 and for SAMS is 14.54. The weighted cognitive levels of the schools increase monotonically as the school level increases.

TABLE I. Weighted Cognitive Level of Each Course

Course	Terminal Objective*						Weighted Cognitive Level
	K	C	Ap	An	S	E	
CAS^3 Phase I	47	1	11	1	0	0	1.68
CAS^3 Phase II	2	2	15	2	11	0	8.06
CGSOC Core	10	34	25	21	32	21	12.75
CGSOC Electives	1	6	12	13	82	2	13.28
SAMS	0	1	0	3	22	0	14.54

*Key

K	=	Knowledge	An	=	Analysis
C	=	Comprehension	S	=	Synthesis
Ap	=	Application	E	=	Evaluation

Course structure. The instructional method used in each of the schools was analyzed. The data used for analysis were derived from the POIs obtained from the College. Table II shows the number of hours taught using all the various teaching methods used at the College and their proportion of the number of total course hours expressed as percentages. Courses analyzed were CAS^3 Phase I, CAS^3 Phase II, CGSOC Core Curricula, and the SAMS course.

TABLE II. Teaching Method* Hours Taught and Percentages by Course

Course	Hours	C/S	D	PE	GS	E	IS	Others
		Teaching Method*						
CAS^3 Phase I	144.0	0.0	0.0	0.0	0.0	0.0	144.0	0.0
CAS^3 Phase II	307.5	84.0	0.5	20.0	0.0	0.0	0.0	3.0
CGSOC Core	766.0	342.5	20.5	22.0	55.0	13.0	0.0	13.0
SAMS	2,116.0	472.0	0.0	664.0	0.0	4.0	976.0	0.0
College Totals	3,333.5	898.5	21.0	1,206.0	55.0	17.0	1,120.0	16.0
Percent		27.0%	0.6%	36.2%	1.6%	0.5%	33.6%	0.5%

*Key for teaching method for Table II and Fig. 2

C/S	= Conference and/or Seminar	E	= Examination
D	= Demonstration	IS	= Individual Study and Personal Instruction
PE	= Practical Exercise	Others	= Including Film, Television, and Self-Paced
GS	= Guest Speaker		

We found that the set of teaching methods that each school uses is unique and that the distribution of teaching methods varies greatly among the schools. There are three teaching methods that are much more common than the others. In order of frequency, they are practical exercise (PE), individual study and personal instruction (IS), and conference/seminar (C/S). The "others" category includes the balance of the teaching methods shown in Table II. Figure 2 graphically displays this information.

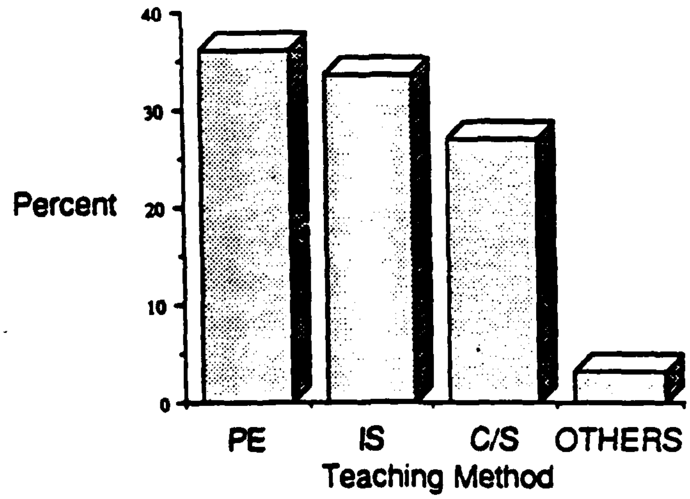

Fig. 2. CGSC teaching methods.

School enrollment. Table III displays the approximate number of students that were enrolled in academic year 1986 for CAS^3 Phase I, CAS^3 Phase II, CGSOC Resident Course, SAMS, and SOCS. SOCS accounts for about 86% of the number of officers serviced by the college; and CAS^3 accounts for about 12%. If, as has been mentioned in discussions with SOCS staff, the Reserve Components implement CAS^3 for their captains, an additional 15,000 SOCS students could be expected. Clearly, SOCS has affected and, in all likelihood, will continue to affect the largest number of Army officers of any school in the College.

TABLE III. Number of Students in the Courses of CGSC

Course	Approximate Number U.S. Students	Percent of Total
CAS^3 Phase II	4,500	11.7
CGSOC	750	1.9
SAMS	52	0.1
SOCS*	33,000	86.2
Total	38,302	

*SOCS enrollment includes approximately 11,400 CAS^3 students and 21,600 CGSOC Nonresident Course students.

At present, there is no computer usage for academic purposes in SOCS, so this area deserves to be explored from the perspective of potential payoff for using computers. The next most important school from the point of view of number of officers affected is CAS^3 Phase II, where approximately 4,500 officers per year are affected, 12% of the students taught by the College. The CGSOC Resident Course accounts for only about 2% of the U.S. students taught by the College.

Computer usage at CGSC. A review of the formal documentation at the College and discussions with the faculty, staff, and students agree that there is a pressing need for computers to be used at the College. In particular, the following statements were noted:

- A need exists for computer simulations in the classroom at CGSOC.

- No method exists within the College for interoffice computer-to-computer communication. Therefore, all interaction (for example, interoffice memos, review of lesson plans, course authoring, letter writing, visual aids development, modification, etc.) must be done by hand carrying documents.

- There is no automated method for electronic communications to occur between offices in CGSC and other offices, such as the Media Support Center or the DOIM at Fort Leavenworth.

- CAS^3 is actively pursuing a plan to bring computers into each classroom, to establish computer programs for students to use, and to require its faculty to become computer literate to the extent that they can use all computer assets available to the students.

Findings

The cognitive level taught in the CGSC increases as one progresses from CAS[3] Phase I through SAMS. This actuality has implications for the introduction of computers into the curricula because the cognitive level affects the design of the computer applications.

Only three significant teaching methods are currently used in the College: practical exercise (36.2%), individual study and personal instruction (33.6%), and conference/seminar (27.0%). The use of computers in the classroom will affect these methods and must take them into account.

When one considers the number of students in the various schools, SOCS dominates the totals (84%). The first consideration concerning where computers might provide opportunities to improve efficiency should be in SOCS, then in the next most populous school, which is CAS[3] with 14% of the students.

As currently configured, there is marginal use of computers in the curricula and in the office automation functions at CGSC.

As the project team progressed through the analysis of the College data and discussions with the faculty and staff, it found that the data for courses were changing and being updated.

Task B (Analysis of Staff Officer Knowledge, Skills, and Abilities) Summary

Task B Description

Task B identified and analyzed the KSA required of staff officers for the effective performance of command and staff tasks.

Methodology

The KSA needed to perform effectively in command and staff positions by the U.S. Army in the field are not listed explicitly in any formal, official form. Consequently, the goal of the task was approached through analysis of the duties and responsibilities of the incumbents of those positions as they are described in FM 101-5. Three categories of KSA pertinent to the project can be distinguished from examination of the manual.

1. The general knowledge of military matters and affairs and their relationship to national goals that form part of the professional qualifications of all Army officers.

2. The common KSA needed to perform the principal staff functions defined in FM 101-5.

3. The particular KSA needed to perform the specific tasks involved for tactical command coordinating staff officers as each plays his role in advising and assisting his commander.

The contents of each of these categories was inferred from the FM 101-5 analysis. This analysis was aided by our team members' active duty experience in the area of Army staff operations. A cognitive level signifying the kind of intellectual effort involved in acquiring it was assigned to each set of common KSA needed for performing principal staff functions and to each set of particular KSA associated with specific staff tasks.

Conceptual types of support through automation were considered for each task and its implied subtasks to identify opportunities to use computers to assist in the performance of the tasks. Necessarily more subjectively, conceptual categories of ACL were considered for each task to identify opportunities to use computers in teaching the KSA needed for the performance of the task. (See the detailed explanation of ACL on page 46.)

Duties and responsibilities of support command staff and special staff officers and staff tasks associated w ith following common staff procedures were also identified for later comparison with CGSC curricula.

Results

The data relating to KSA required of tactical command coordinating staff officers were organized for presentation in forms facilitating analysis and for later comparison with the curricula of CGSC schools. As shown in Tables IV and V, the number of staff tasks implied by the duties and responsibilities listed in FM 101-5 varied appreciably with the principal staff

function involved and with the particular staff officer performing them. Similarly apparent from those tables, cognitive levels of associated KSA varied with the tasks across the entire range of cognitive levels.

In the following tables, Roman numerals signify the principal staff functions defined in FM 101-5:

I	=	providing information
II	=	making estimates
III	=	making recommendations
IV	=	preparing plans and orders

The cognitive levels used are those of Bloom's Taxonomy.

TABLE IV. Distribution of Tasks with Cognitive Level by Principal Staff Function

Cognitive Level	Staff Function				
	I	II	III	IV	Totals
Knowledge	1	0	0	0	1
Comprehension	16	1	0	0	17
Application	24	1	16	23	64
Analysis	26	9	22	13	70
Synthesis	4	1	4	12	21
Evaluation	0	2	2	5	9
Totals	71	14	44	53	182

TABLE V. Distribution of Tasks with Cognitive Level by Coordinating Staff Officer

Cognitive Level	Staff Officer					
	G1	G2	G3	G4	G5	Totals
Knowledge	0	1	0	0	0	1
Comprehension	0	1	8	6	2	17
Application	7	22	9	17	9	64
Analysis	12	11	20	11	16	70
Synthesis	3	5	11	0	2	21
Evaluation	1	3	4	1	0	9
Totals	23	43	52	35	29	182

Opportunities to support the performance of staff tasks by automation were considered plentiful in performing each principal staff function by each staff officer, as shown in Table VI. (No attempt was made to determine the extent to which automation currently exists in the Army in the field.)

TABLE VI. Percentage of Staff Tasks Supportable by Automation by Function and Staff Officer

Function	Staff Officer				
	G1	G2	G3	G4	G5
I	100.0	94.4	94.7	100.0	80.0
II	100.0	100.0	100.0	100.0	100.0
III	25.0	50.0	62.5	50.0	50.0
IV	100.0	71.4	78.6	100.0	38.9
Totals	73.9	79.1	80.8	88.6	79.3

The KSA associated with every staff task were considered to be suitable for at least one ACL.

Findings

There is evidently no officially approved listing of the KSA needed for assuming the duties and responsibilities of staff officers serving in headquarters of combined arms commands of the Army in the field. Those KSA can be deduced from the description of those duties and responsibilities appearing in FM 101-5, probably best inferred by persons with experience on staffs of that kind.

As defined in FM 101-5, the staff tasks associated with the principal staff function of preparing plans and orders fall logically into two categories. Some are clearly involved in the area of preparing plans and orders, while others are obviously related to the function of exercising staff supervision over a variety of activities in the areas of interest of each coordinating staff officer. Supervisory tasks could be continuous as in command activities. Others are involved with assisting with the commander's supervision of the execution of his orders.

Opportunities abound to support the performance of staff tasks by various types of automation. (For examples, see the report entitled Analysis of Staff Officer Knowledge, Skills, and Abilities.) Similarly, many of the KSA needed for performing in tactical command coordinating staff positions can be taught by some form of ACL to learning when the appropriate software is written. The higher the cognitive level of the KSA, the more complex that software will be.

Task C (Assessment of Technology and Computer Literacy) Summary

Task C-1 (Assessment of Computers in Education) Description

Task C-1 was the assessment of computers in education at various universities and research centers. Its goal was to examine the current state of implementation of computers in education through visits to several universities and research centers. This task is important to the overall project because one cannot make recommendations regarding effective applications of computers in education without having first examined history. Final project recommendations will be examined in light of findings of Task C-1, ensuring the application of lessons learned.

Methodology

A sample was taken of East and West Coast sites, which have been highlighted in the literature for being exemplary in the area of computer applications in education. Two teams from Los Alamos visited the eight different institutions in April, 1987. The institutions were the following:

Education Centers	Research Centers
Stanford University	Instruction and Research Information System (IRIS)
University of California - Irvine	Institute of Mathematical Studies in Social Sciences (IMSSS)
Drexel University	Learning Resources Development Center (LRDC)
Carnegie Mellon University	Computer Curriculum Corporation (CCC)

To provide consistency in data collection, a data sheet was designed and used at each site. The data sheet contained questions regarding software, hardware, main applications functions, organization, training strategies, and lessons learned. Data analysis consisted of compiling the completed data sheets, reducing the data to tables and graphs, and seeking patterns in the experiences of the eight institutions, which would be transferable to computer applications at the CGSC.

Results

Results from data analysis indicate that there are few patterns observable at the various institutions visited. A great diversity exists in the types of applications, software, hardware, and implementation approaches used at the eight institutions. In hardware, each site settled on a standard PC-based configuration. If a mainframe was used, it was used only to support file transfer and electronic communication. In software, in-house development was carried out at all institutions because commercially available software was not available for their specific educational applications.

In the area of instructional strategies used for the computer applications in education, no particular strategies emerged as being universally used. The most commonly used strategies were drill and practice and tutorial, but the following methods were also heavily used: simulation, intelligent tutoring systems, games, problem solving, and testing.

In the area of lessons learned, however, some trends were observable. The lessons learned were collected in a free-form manner; thus, across-the-board comparisons are not possible here. Nevertheless, it was interesting to note that many institutions independently indicated the same lessons learned. The lessons learned that were experienced at two or more institutions are as follows:

- Mass replacement of existing courses is not seen as an effective way of integrating computers into the curriculum. Instead, supplementing existing courses is effective.

- Younger students, who tend to have more experience using computer than older students, are able to adapt faster to using computers for education.

- Computers can be used for any subject area being taught; any subject area lends itself to computer-based training.

Introducing computers to the instructors was a critical element here, but there was no consensus of how best to accomplish this task. Some institutions provided intensive instructor workshops; others made it an option for instructors to take advantage of the opportunity or not as they wished, while still others provided incentives for instructors to be the drivers of the courseware/software development efforts.

Findings

There is no apparent consensus of usage of computers in education. Computers are found to be useful in a wide range of functions related to supporting instructors, students, and existing courses. Widespread replacement of existing courses is not found in institutions with well-recognized success in this area. This information leads to the suggestion that the CGSC integrate computers as productivity aids for students and instructors as well as for supplementary exercises in existing courses.

Elementary, secondary, and undergraduate students are receiving more exposure to computers at earlier ages. Early exposure seems to lead to better performance and less anxiety. This has implications for integration of computers into the CGSC. The trend in institutions of higher education is to provide opportunities to ensure computer literacy among students in almost every major field. Therefore one can assume incoming CGSC students will be more computer literate in the future. One must also assume that computer literacy training needs to be provided for CGSC students who have not been exposed to computers through previous education or experience and for the faculty and staff.

Regarding hardware, the project team observed the trend that each institution decided upon one main vendor for its personal computers and then continued with that vendor for all software development regardless of department. This practice facilitated compatibility of software, consulting, electronic communications, file transfer, and maintenance. This situation suggests that the current trend in the CGSC of having available a potpourri of hardware for different applications should be stopped and that one main hardware configuration be accepted as standard.

The trend toward personal computers linked together via a mainframe for electronic communication was predominant at the institutions visited. This approach was used instead of the old system of using a large mainframe with many nonintelligent terminals linked to it. The ratio of students to workstations varied depending upon anticipated usage. When heavy usage was expected, the ratio approached 1:1. CGSC should strive to make PCs the focus for students and instructors, leaving the mainframes for automated data processing applications, communications, and some classroom applications.

In-house development of the software for the educational applications was the trend at the various institutions visited. They did use off-the-shelf word processing and spreadsheet packages for multipurpose applications, but no commercial packages existed for their specific courses. Accordingly, the CGSC should assume that in-house efforts, supported by contractors, will need to be initiated for computer-based training and simulation development applications.

A wide range of instructional strategies was observed, with the particular selection being linked to the application. Consequently, during the design phase and for the purpose of selection of the appropriate instructional strategy, an analysis of the application should be planned into any in-house development project.

Task C-2 (Assessment of Technology) Description

Task C-2 dealt with the assessment of technology. The goal of C-2 was to study the current technology of computer hardware and software for educational applications through reading and study of vendor products. This task is important to the overall project because the final recommendations need to be based on the capabilities of current and future technologies. Short-term recommendations must be based on current capabilities, but those recommendations must also reflect the need for the software and hardware to be flexible and expandable for technological innovations. In addition, portability of code and the requirement for positive transfer of training (that is, ability for a student or faculty member to apply what he/she has learned about one computer system to another) are significant.

Methods

The first step in this assessment process was to identify the scope of the technology to be studied. The project team decided to identify technologies associated with the relevant CGSC functions that would involve application of computers. These functions are as follows:

> **Personal Productivity:** Day-to-day activities of students, staff, and instructors in the area of document preparation, scheduling, note taking, calculating, and analysis.
>
> **Administration:** Staff work that supports the functioning of the College as well as the course delivery by the instructors. Areas supported under administration include course registration and scheduling, record keeping, and secretarial and clerical support of CGSC staff and faculty.

Research: Staff and faculty research into their particular areas of specialty, the content and organization of the curriculum, technological support, and Army doctrine. As defined here, research refers to accessing of references for research through the library. These references include both Army manuals and texts and civilian publications.

Computer-Based Training (CBT): The replacement or supplementation of existing teaching with instruction delivered to the student on the computer. CBT can include a range of levels of instruction from remedial to enabling and can include a range of instructional strategies from drill and practice to sophisticated simulations.

Training Aids: Construction of materials that instructors use to deliver their courses in the classroom. In the past few decades, this function has evolved from chalk and notes to computer-generated slides and realistic video. A type of training aid that is widely used is the view graph.

Course Materials: Textual materials provided to the student as part of the particular school of the CGSC. These printed materials, written by CGSC faculty, are formatted and produced by the school and require frequent updating. Administrative support staff play a large role in the production of these materials.

Communication: Internal to the CGSC, for the purpose of making administrative arrangements regarding scheduling, assignments, problem resolution, and research. External to the CGSC, for the purpose of information retrieval, planning, research, and decision making.

After defining these functions, research was initiated to isolate hardware, software, development environments, units of utility, and cost for each function. Data sources included direct contact with vendors, vendor shows, computer magazines and journals, and experience with the technology at Los Alamos.

Then the project team compiled the data in a tabular fashion and systematically compared the options. Next, the project team highlighted recommended options to use in compiling the final project recommendations.

<u>Results</u>

Results from the data analysis for this task indicate that certain hardware configurations and software packages are preferred. Many options are available for all of these functions. This study does not claim to be exhaustive but includes leading candidates in each of these areas.

For the particular functions identified, the project team broke down various options. The entire breakdown and tables along with recommendations for hardware configurations and software packages are provided in the Assessment of Technology standalone report of Task C-2.

Findings

Using results of this task as a guide, CGSC should identify a single personal computer-based system as a standard. CGSC should select a system that is both adaptable to different applications within the College and expandable for future technologies. To facilitate positive transfer of training, this system should be compatible with other Army hardware and should readily accept various peripheral devices for different functions.

Using results of this task as a guide, CGSC should identify specific software packages for the instructor's standard configuration: spreadsheet software, word processor, slide making package, communications software (and hardware connections), general purpose organization software (for example, calendar and note taker), and an outlining package for preparation of instructional materials. This configuration then should be expanded for College staff with the addition of database management systems, graphics packages, and desktop publishing software and for computer-based instruction development with authoring systems.

The college should identify a single point of contact for technology recommendations and support. The complexity of the decisions for standardization of software and hardware, as well as consulting and maintenance considerations, demands centralization. In addition, enforcement of standards is difficult without a single, well-identified point of contact. This point of contact would also be responsible for keeping up with the state-of-the-art in the relevant technological areas and upgrading the standard software and hardware as required.

CGSC should identify a hardware configuration for high-fidelity, major simulations. Such simulations demand more powerful processors and greater memory than available in PCs and also require high-resolution graphics and different development environments.

Based on the results of this study and other Army work in this area, for example, electronic information delivery system (EIDS), the college should identify a standard computer-based training hardware and authoring system. It should also recognize the area of personal productivity software as distinct from the function of computer-based training and simulation and identify a point of contact for computer-based training within the College, even though some or all of the development may be contracted out. This point of contact would report to the technology single point of contact, but the relationship would reflect the complexity and degree of specialization of the CBT field.

CGSC should rely on existing organizational structure for high-fidelity simulation points of contact and recognize these as distinct from the technology or CBT points of contact.

Task C-3 (Assessment of Computer Literacy at CGSC) Description

Task C-3 assessed the computer literacy in the CGSC. Its goal was to study the current level of computer literacy in the staff, faculty, and student populations of the various CGSC schools through the administration of a questionnaire. The results of this task were critical to the overall project in terms of the implementation plan. The level of computer literacy of the various

categories will impact the sequence and rate of implementation of computers into the curricula.

Methodology

There are many ways to measure a person's level of computer literacy. The ideal methodology is to devise a valid test of computer literacy and administer the test to the individuals in a sample population. Such a test might consist of giving those individuals two new commercial software packages and a PC and asking them to bring up the packages on the PC (using the documentation) and create two examples of usage of each package within a four-hour period. This test provides an objective measure of individual performance, but it is very time consuming and impractical unless there is adequate staffing for such a study.

The methodology chosen here results in a subjective measure of computer literacy, based upon asking some questions about an individual's background with computers. This subjective approach is less costly and can more efficiently reach a large number of people than the objective test approach.

An even more subjective approach is to ask questions about an individual's opinion regarding his/her own computer literacy. This approach was not taken here because of the varying definitions of computer literacy as well as because of the fact that humans are not very good at estimating their own capabilities.

The questionnaire used here was compiled based upon knowledge of the literature in the area of computer literacy and upon knowledge of some of the possible background experiences of the sample population. The brief questionnaire asked 12 questions relating to rank, college major, highest degree, and experience using and programming computers. It also asked whether a computer course and CAI had been taken.

The questionnaire was sent to the Office of Evaluation and Standardization of the CGSC for administration to the entire staff and faculty and to a sample of students selected from each of the schools. The questionnaires were administered in April and returned to Los Alamos for compilation. Here at Los Alamos, the project team input the data into the CRISP statistical database program.

Results

The compiled results of the 696 questionnaires distributed are provided in detail in the Task C-3 report, Assessment of Computer Literacy at CGSC. One of the major parameters examined here was computer literacy. Computer literacy is defined here as follows:

> **A person is considered computer literate if he/she has programmed in any computer language.**

There are many different definitions of computer literacy in the literature; the definition chosen depends upon the context in which it is used. The definition used here was selected because a major focus of this study was computer applications in the area of major simulations. Comprehension of such simulations requires the ability to understand program structures which, in turn, requires a knowledge of programming.

The project team has reviewed existing major simulations and has found that because of the complex user interfaces, a programming background would be required to accurately use and understand the actions occurring within the simulation. As time elapses and as the new advancements in user interface design are applied to the design of major simulations, the definition of computer literacy for this purpose will become more lenient.

Data indicate that the most computer literate group is the CGSOC students, and the least computer literate is the staff. Within the students, the CGSOC students are more literate than the CAS3 students. Although this seems contradictory to the trend for younger students to be more literate, it is attributable largely to more CGSOC students owning computers (30% vs. 17% for CAS3 students), which is probably due to greater income and having school-age children. The percentage of those sampled who have had hands-on computer experience (84.2%) and word processing experience (71.4%) are very high. The degree of preparedness for personal productivity types of application is high compared to that for major simulations.

One of the main computer applications in education is CAI. In this area, the degree of prior experience among both students and faculty as low (39.2%), with no significant differences between the prior experience of students and faculty.

The probability that a PC will be used frequently is related to the ease of access to the hardware. However, it does not follow that easy access to a PC will lead to frequent use. More than half of the individuals sampled owned a PC. The CGSOC students were most likely to own a personal computer, followed by the CGSOC faculty, and then the CAS3 students and faculty.

The degree of computer literacy is related to the major field of study in college. (For an expanded discussion, see the report entitled Assessment of Computer Literacy at CGSC.)

Findings

According to the definition of computer literacy used here, the faculty displayed a lower level of literacy than the students. Therefore, before existing major simulations are implemented in the CGSC, the level of computer literacy must rise among the faculty.

The most frequent use of computers among the individuals sampled was word processing, and most of those sampled had hands-on computer experience. This information suggests that the faculty, staff, and students could become frequent users of personal productivity software (for example, word processors) without significant anxiety.

Most of those sampled did not have experience with CBT. Applications of CBT have been available in schools and institutions of higher education for over two decades. The data are encouraging in the sense that there are many CGSC faculty and staff with no preconceived notion of the degree of worth of CBT. On the other hand, some anxiety can be expected in the implementation of CBT at CGSC.

The major field of academic study appears to have influenced the degree of computer literacy in the faculty and students. If the Army continues to attract more liberal arts students and fewer science majors, CGSC may have to provide basic computer training for faculty.

Task D (Analysis of Institutional and Financial Constraints) Summary

Task D Description

The primary goal of Task D was to determine if there are existing or programmed (one- to five-year) constraints in personnel, organizational, facility (especially computers and communications), or financial resources that would seriously impact the successful implementation of computers in the CGSC. The results of this task assisted the overall project in development of the plan of implementation. Any serious resource constraint or barrier must be weighed in the creation of a scheme by which the College can move toward increased computerization.

Methodology

To provide a consistent means for evaluation of the personnel strengths and trends, organization structure and functional missions and operations, funding programs and trends, current computer utilization, and programmed changes for the period through 1992, an analysis was made of the document A Report of the United States Army Command And General Staff College, 1984-85 Institutional Self Study, dated March, 1985. This study provided the means by which analysis and understanding of the various elements of the College could be accomplished. The report included self-evaluations by each department regarding its strengths and weaknesses and the framework needed to request updated information concerning the latest facts and potential impact of changes in essential resources.

Throughout the duration of the project, team members conducted direct, informal interviews with faculty and staff of the CGSC during visits to Ft. Leavenworth. In late July, a letter was dispatched requesting an update of personnel strength, organizational changes, current computer inventory, and financial data. Two representatives from the team visited the post to clarify questions and to continue discussions with College and installation personnel to obtain additional data. There are indications that joint operations will be given greater emphasis in future college instruction.

Key Assumptions from the CGSC Five-Year Plan

- The present College organization and course offerings and lengths will not change significantly in the near term.
- The current enrollments at the programmed numbers of SAMS (52), CAS^3 (4,500), CGSOC (980), and SOCS (33,000) will remain consistent over the next 5 years.
- The College will have expanded roles in support of the BCTP and development of doctrinal literature.
- Planned educational facility construction and renovations will occur as currently programmed.

Results

Analysis of the personnel data suggests that the College has been able to justify additional staffing requirements as the missions have changed. Since 1985, total requirements (officers, enlisted, and civilian) have increased 30.7% to 1,099. During the same period, total authorizations have increased 25.8% to 960. The significant constraint is the increasing shortfall in required to authorized civilian strengths. The current shortfall of 101 civilian positions represents a 6.6% decrement. Three departments have 30% or greater shortfall in civilian authorizations: Military Review, Director of Academic Operations, and CARL. It is against this identified constraint that the administrative ACL should provide some relief.

As the College adopts new missions, for example, BCTP (collective training) and increased command and control (C^2) research and development, additional resources will be required. It is essential that the mission of the DACTS be emphasized and the Director be given the necessary resources and senior executive support to carry it out. Simply stated, the DACTS mission is to plan, organize, develop and administer the implementation of the College's computer-supported educational systems, and serve as the coordinating element and principal staff advisor with respect to all management information, automatic data processing, computer, and associated communications equipment. The Director currently lacks the resources to accomplish this mission. The unique job specifications and qualifications for experienced computer-trained personnel to assist in the development of in-house, military-oriented, education programs will make them difficult to obtain.

Analysis of the funding history suggests that the College has been aggressive in documenting requirements and in pursuing receipt of adequate funding support for execution of its programs. The trend in total program growth from FY85 to FY90 reflects a 16% growth rate to approximately $12,000,000. The important trend is that the Element of Expense - Personnel will account for 70% of the total dollar FY90 funding program. However, with the introduction of significant computer assets and the desire to develop appropriate courseware and simulations, the funding requirements for contracts and equipment will increase. Sound long-range planning supported by the well-developed rationale should result in obtaining approval from higher headquarters. The current five-year plan and information management plan include requirements for both Operations and Maintenance - Army and Other Procurement - Army funds and have been submitted through the Training and Doctrine Command (TRADOC) for consideration by Department of the Army/Department of Defense (DA/DOD).

The College facility plans include documentation to support Military Construction Army funds to build a new General Instruction Building (GIB) with a new facility for CARL and a learning resource center. The following chart summarizes the current construction plans.

CGSC Facility Construction Plans

Project	Status	Completion
General Instruction Building	MCA FY89	FY 90
CARL	MCA FY89	FY 90
Bell Hall Renovation	Pending FY91	FY 93
BCTP/Simulation Facility	Design FY89	FY 89

The construction program, like most major multiyear projects, is behind schedule, but plans exist and include computer and communication requirements. The key requirement is for these plans to allow for an open architecture for computers and communications that can be reviewed and revised as new technologies become known. Plans must allow for high-tech classrooms for each of the schools. Engineering waivers may be required so that current plans for renovation of Bell Hall can proceed. A facility constraint could occur if the waiver is not approved.

The SOCS represents an important interface between the College and the Army officer corps. Despite this fact, the project team heard local complaints about the lack of currency of the materials distributed in support of the CGSOC Nonresident Course. This lack of currency may be due in part to the College's emphasis on resident instruction, most of which is presented to staff groups. The organizational positioning of SOCS, coupled with its rank structure, puts it at a disadvantage in competing for resources. The formulation of the functional requirements and development of the specific system requirements for a network to support the SOCS mission are serious challenges facing the College.

Findings

The College has a conglomeration of computers. Nevertheless, the temptation to accept any new computer (with little analysis of maintenance, training, and sustaining costs versus benefits to be gained) should be avoided. With the infusion of Z-248 computers, the College effort should be toward adoption of a standard TDA computer and phasing out of the Hazeltine, Corvus, Syntrex, Wang, et al. systems and creation of an integrated approach. To facilitate electronic communications, file transfer, portability of programs, personnel productivity, administration, and maintenance and support, a standard computer to meet the needs of the staff, faculty, and students should be adopted.

A single focal point within the College for planning for the use of computers is a requirement. DACTS is the obvious choice. The current TDA organizational structure does not provide the necessary resources for in-house development of CBT. If the CGSC is to participate in the mainstream of using computer applications in education, it will have to use its subject matter experts in conjunction with a small internal DACTS development team to examine and exploit new technology and its application to higher level education. This team should continuously expose the teaching departments to technology and cross-fertilize successful applications among schools and departments.

Unity of effort is essential if the introduction of computers into the College is to be successful. The noted lack of a formal "schoolhouse" structure for the CGSOC within the curricula warrants further evaluation. Key management functions of planning, organizing, coordinating, directing, and controlling should be applied in the priorities of resident/nonresident instruction and doctrine development and then to other missions. (See the Analysis of Institutional and Financial Constraints report [Task D].)

The development of the SOCS as an "electronic university" has been proposed, and several internal and external studies have been accomplished to evaluate the requirements. Technology exists to modernize SOCS with an automated capability through which its functions can be accomplished on the Z-248 baseline computers and its students can begin corresponding via a terminal. The project team identified two SOCS requirements; one unrelated to technology. First, an educational requirement exists to find the most effective way to transfer the staff group instruction (SGI) techniques preferred by the resident courses into an effective training technique for use by nonresident students. Satisfying this requirement should be undertaken as a major project by the "principal" of the teaching departments for the CGSOC course and by the heads of the other schoolhouses. Once the procedures for conversion of these high cognitive level courses have been created, all materials for all resident and nonresident courses of instruction will be completed concurrently. This situation will insure that nonresident courses are as current as the resident courses and that production requirements (for example, Media Support Center publications) are optimized and cost effective.

The second requirement relates to the development of a functional baseline computer network for the CGSC, required specifically to support the SOCS missions. Studies have been conducted to address automation within SOCS. The project team believes that additional studies are not warranted but that specific actions should begin on the development, on an iterative prototype basis, to build the required networking capability.

Task E (Army Command and Control Concept Study) Summary

Task E Description

The goal of Task E was to identify the effects on CGSC instruction of predictable changes in command and staff functions or their performance that will follow innovations in doctrine, organization, and technology. Accomplishment of Task E permitted anticipating changes in teaching requirements at CGSC that will affect the kinds of applications of computers that can be expected at the College 5 or 10 years from the present.

Methodology

Nine retired Army general officers were consulted on a range of matters dealing with the question of change to be expected on future battlefields and the concern of how that change will be reflected in the requirement to prepare Army officers to perform effectively on those battlefields. The interaction was called the Army Command and Control Concepts Study.

To generate a wider variety of responses to a range of primary questions, the conference was periodically divided into different types of sessions:

- "Group think" sessions led by a Los Alamos facilitator, where all the participants addressed specific issues and questions outlined in a session guide.
- Team sessions, in which the entire group was split into two separate teams to consider questions provided prior to the conference.
- Team briefing sessions attended by all participants where a spokesperson for the separate sessions provided a summary of the team's findings.

Results

Predictably, discussion of future changes on the battlefield led to more wide ranging discussion of the manner in which the Army educates its officer corps at CGSC, in the Army school system in general, and through its assignment policies. The Army's current and projected use of computers also drew extensive comment from the participants. Once discussions began, additional relevant questions and topics invariably were introduced, resulting in additional findings pertinent to the primary questions.

Findings

The military decision making process and fundamental staff operations will not change substantially in the foreseeable future; the time available to commanders and staffs for performing their functions in combat, however, will be shorter as the pace of battle is likely to increase.

Introduction of new technology for surveillance, target acquisition, and information collection and management systems will add greatly to the amount of data available to commanders and staffs in future conflicts and, therefore, to the requirement for processing those data to use them most effectively.

Doctrinal and technological modifications may lead to changes in the composition and organization of future staffs to accommodate accelerated battle dynamics and a greatly increased flow of data.

Increasing application of automation in field headquarters and projected use of standardized combat simulation models and games for training throughout the Army will lead to a greater use of computers in CGSC instruction.

Widespread Army use of computers should lead to exporting instruction from CGSC to the Active and Reserve Components of the Army in a less expensive, more responsive, and more effective form than is currently the case. It should also lead to other forms of closer contact and more direct interactions between CGSC and the Army in the field.

Task F (Comparison of Knowledge, Skills, and Abilities to Learning Objectives) Summary

Task F Description

The goal of Task F was to draw appropriate conclusions regarding the performance of CGSC in training staff officers by comparing the KSA required for the performance of command and staff tasks as identified in the Analysis of Staff Officer Knowledge, Skills, and Abilities report with CGSC curricula as described in the CGSC Analysis report.

Methodology

The results and findings of Tasks A and B provided data for the comparison of the curricula of the schools of CGSC with the KSA needed to assume the duties and responsibilities of tactical command coordinating staff officers. The subcourses of the two phases of the CAS^3 Course and those of the CGSOC Regular Course were examined for learning objectives pertinent to teaching the common KSA needed by all staff officers for the principal staff functions and their component tasks and for following staff procedures. As the emphasis in CGSC instruction is on tactical command coordinating staff operations, the results of comparing curricula and KSA focus on the tools needed to perform those operations. Cognitive levels of subcourse learning objectives were compared with those of the KSA to which they applied.

Results

The project team identified and listed the subcourses related to the acquisition of the general knowledge defined in Task B as constituting the first category of KSA needed by tactical command coordinating staff officers.

The project team listed the learning objectives of all pertinent CGSC subcourses relating to the common KSA needed by all tactical command coordinating staff officers for performing the principal staff functions described in FM 101-5 for each of the functions. The project team also listed the learning objectives of all pertinent CGSC subcourses relating to the particular KSA needed to perform specific staff tasks for each tactical command coordinating staff officer by the principal staff function of which the tasks were components.

Cognitive levels of the learning objectives and of KSA also appeared in those listings. (See Comparison of Knowledge, Skills, and Abilities to CGSC Learning Objectives, Task F report.)

The listings were examined for their salient features of significance to the goals of the project, and the results of the examination were presented in various tabular and graphical forms. In general, they show that the principal staff functions and the tasks of tactical command coordinating staff officers are covered extensively in the CGSC curricula.

Gaps in CGSC instruction surfaced in the following forms:

- As CGSC is not primarily training individuals for particular staff positions but rather for service in all of the positions, some specific staff tasks are understandably not addressed in the instruction. However, some tasks are not addressed presumably

because there is no currently feasible method of doing so in suitable fashion. These tasks may be preeminently those pertaining to staff supervision of the execution of the commander's orders.

- Some coordinating staff interactions with members of other staff elements (for example, the special staff and support command coordinating staff) are apparently not explicitly covered in CGSC instruction.

- Evidently, little or no instruction is given in some of the common staff procedures listed in FM 101-5 as applicable to staff operations in general.

There are discrepancies in the relationship of cognitive levels of CGSC subcourse learning objectives to those of the related KSA. Some of these discrepancies may be explained by the necessarily subjective nature of the assignment of cognitive levels to both the learning objectives and to the KSA.

Findings

The curricula of CGSC schools are generally designed appropriately to teach the KSA needed by their graduates in assuming the duties and responsibilities of their subsequent assignments in tactical command staffs. To the extent that this general finding does not apply to some KSA that can be inferred from the doctrinal material in FM 101-5, it may be advisable for CGSC to review its curricula to ensure that a conscious decision supports each failure to address those KSA.

Task G (Identification of Computer Opportunities) Summary

Task G Description

In completing Task G, the project team used the results of Tasks A, B, and F to identify specific opportunities to apply computers in instruction and training at CGSC and to indicate how those opportunities could be applied to subcourses in implementing a preferred instructional strategy.

Methodology

Each subcourse of the CAS^3 and SAMS courses and CGSOC was examined for the purposes of determining which categories of ACL would be suitable for achieving at least some of the subcourse learning objectives. The examination also produced estimates of the number of subcourse hours that might appropriately be devoted to computer applications of each category after suitable courseware had been designed and produced. (See the detailed explanation of ACL on page 46.)

Results

The project team has listed itssuggestions for applying computers in teaching the courses taught by CAS^3, SAMS, and CGSOC by subcourse as a percentage of the total number of subcourse hours that might be devoted to applications from *each* category defined by the team. It also endorses the choice of staff group instruction as the primary instructional method to be used at CGSC. Inasmuch as very little of the needed courseware for all of the suggested computer applications has been developed, the suggestions describe a situation that can only serve as an eventual goal for CGSC in its projected expanded use of computers in the classroom.

Specifically, the project team believes that computers ought to be used to perform many of the administrative tasks associated with presenting every subcourse taught by CGSC. It also believes that 47% of the total number of classroom hours of the CAS^3 course, 61% of CGSOC hours, and 54% of the SAMS course hours would provide improved instruction and training if ACL, in addition to those for administration, were introduced. The suggestions of the project team for the percentage of hours of each course that might appropriately use applications from each category of ACL are summarized in the following table.

TABLE VII. Percentage of CGSC Course Hours Using Computer Applications* from Each Listed Category

Course	0	1	2	3	4	5	6	7
CAS[3]	53.2	100.0	0.0	21.4	20.5	0.8	0.8	3.3
CGSOC	35.8	100.0	2.4	28.5	7.9	6.3	9.4	9.7
SAMS	45.9	100.0	0.0	0.0	18.9	0.0	28.2	6.9

*See page 46 for a detailed explanation of ACL.

0 = No application except administrative is appropriate
1 = Administration
2 = Testing
3 = Computer-assisted instruction
4 = Simulation for individual training
5 = Intelligent tutoring system
6 = Gaming
7 = Simulation for collective training

Findings

Staff group instruction is the preferred instructional strategy for all of the schools of CGSC.

There are many opportunities for applying further uses of computers in CGSC instruction.

Acquisition of computers should follow a plan designed to accommodate the courseware that will have to be developed, the other missions of CGSC in addition to individual training, and acquisition plans of the installation and higher headquarters.

The development of courseware for each subcourse and learning objective to which computers will be applied should begin as expeditiously as possible so that software needs can be defined and effort to produce the software may begin.

DISCUSSION

This section brings together the many disparate elements of the study and adds the analytic structure leading to the conclusions. It begins with the College's mission and incorporates two different philosophical views of the college, and then the mission is elaborated further. Then, the nature of command and control, the central theme of CGSC instruction, is discussed. Next, the transition of novices to experts and the use of computers for learning are surveyed. With this background, the state of CGSC is described, forming the basis for a cost benefit assessment of alternatives for the ACL, leading to priorities and recommendations.

Mission and Implied Tasks of CGSC

This section begins with a discussion of the mission of the CGSC because the complexity of the College, its many tasks and schools, and the rapid, dynamic changes occurring in the Army suggest a need to establish the first principles for the analysis. During the study, the team frequently had to revisit the question of who was doing what, with which, and to whom.

The mission of the U.S. Army Command and General Staff College is twofold:

- To develop leaders who will train and fight units at the tactical and operational levels.
- To develop Combined Arms Doctrine and assist in its promulgation (U.S. Army CGSC, 1986).

Instruction

As part one of this mission, CGSC's job is to develop the professional qualifications of individual students. That is, the education and training conducted by CGSC is individual as opposed to collective in the lexicon of the TRADOC instructional system development process. Used in this manner, individual training concerns the end objective of the training process--the development of an individual's skills and abilities as opposed to those of a team (collective training).

Existence of the BCTP office in CGSC adds another element to the instructional mission of the College. The mission of the BCTP Office, as well as the objective of the program, was extracted from the undated BCTP brochure as follows:

> The Battle Command Training task force has been directed to design, plan, develop and implement a training program for the purpose of exercising Army divisions and corps. . . . The Battle Command Training Program will become the focal point for the integration of emerging technology such as tactical automation, knowledge engineering, and decision support systems.

The first quotation describes an environment of collective training, which is in conflict with the individual training mission of the College. While it was not appropriate for this study to judge the BCTP mission, it was necessary to consider the role of collective training within the College and its influence on the individual training mission.

If a Venn diagram of individual and collective training is drawn, there will be an area of considerable overlap, where both types of training are supported. However, the efficiency of a given training vehicle to effect individual or collective training will vary, intuitively doing the best job for the training objective for which it was designed.

The second quotation raised concern with respect to this study for two reasons. First, the examples cited for emerging technology did not include educational technology, suggesting that a caution should be raised. For example, knowledge engineering was used to develop the MYCIN medical diagnostic program, which was subsequently developed into an intelligent tutoring system, GUIDON. While MYCIN was a successful application of AI and knowledge engineering, GUIDON was fraught with problems because it did not reflect the fact that problem solving is very different from teaching how to solve a problem (Clancey, 1982).

As a corollary observation, the emerging technologies of tactical automation, knowledge engineering, decision support, and educational technology are appropriate to both individual and collective training. Hence, it may be inappropriate for the BCTP Office to be responsible for the development of technologies not directly related to its principal mission (collective training).

For these reasons and the state of the art of simulation technology for training (to be discussed later), BCTP was not examined regarding training content, instructional objectives, or appropriateness to the CGSC mission. However, BCTP was examined from the perspective of how it can support the individual training objectives of the College and also from the perspective of potential conflicts because of the division of responsibilities within the College. Details will be seen later in this section.

Finally, concern grew during the study because of the emphasis being given to the Maneuver Control System (MCS) and its introduction into the CGSC curricula. The Army Tactical Command and Control System (ATCCS) and its included MCS still represent a high-risk, developmental program undergoing continuing evolution. Hence, its inclusion in the curricula as a cornerstone for the instructional process was of concern.

However, a memo dated 15 May 1987, subject: Program for Introducing DCCS/MCS 2.0 Automation C^3 Software Training into the CGSC Curriculum, properly identified the program as currently leading to a four-hour familiarization block of instruction. The future of MCS within the College has not been determined. In this project, with its focus on individual training, MCS was treated as a peripheral consideration for the performance of staff functions.

Doctrine

The development of doctrine is a poorly understood process. It represents activity at the highest cognitive levels in which the heuristics of a single author, supported by the judgments of many contributors, are brought to bear on a narrow subject. In such a case, the resulting doctrinal publications must have consistency and clarity.

Alternatively, doctrine development is the mechanistic review of a previous publication through a piecemeal examination of sections of the document. However, whatever approach is taken, the resulting doctrine is prescriptive rather than descriptive in nature.

Within CGSC, the members of the faculty are custodians of the body of knowledge they teach, chief architects of its structure, and guardians principally responsible for its relevance. In this regard, the College is similar to other institutions of higher learning because a dual responsibility for knowledge and teaching exists. However, it is unique because it is the single guardian of combined arms doctrine, responsible to itself for the adequacy of its product.

As was seen in Task D, manpower is a constraint on the College. The shortfall of instructors/doctrine developers suggests that other help be sought for the doctrine development process. Two major sources of help are available. First, the student body of the College (both resident and nonresident) and, second, the officer corps as a whole should be available. The challenge is to capture both their knowledge and their personal support through extra effort beyond their daily duties. Meeting the challenge is closely related to differing views of CGSC.

Two Views of the College

There are two ways to look at the College. Both must be weighed in considering ways to improve instruction. First, there is the perspective of the organizational entity and its mission: how to accomplish the mission within the resources available. Second, there is the external view of those who come into contact with the organization either directly or through its products. The analogy of the half empty or half full glass (reality versus perception) is applicable to these perspectives.

The Inside-Out or Half Empty Glass View

This view sees teaching and doctrinal development as a job. A finite number of students must be processed each year so that they achieve a minimal level of proficiency. Next, a given number of pages of doctrine must be reviewed, updated, or written each year. And finally, information must be distributed to keep both students and the Army at large up to date on the products of the College. Against these requirements is a finite set of resources; the judicious application of them will allow mission accomplishment.

This view is compatible with a systems approach to managing the facility (Kast and Rosenweig, 1979). It ensures that short-term goals are established and met on time. The inside-out view places pressure on the members of the organization to meet quantifiable standards.

The Outside-In or Half Full Glass View

This view places CGSC in a revered position within the Army and hints at the esteem soldiers have for it. It is a view in which the officer sees CGSC as a source of knowledge that will assist him in his career progress. CGSC is seen as the center of excellence of tactical thought in the Army. And, finally, CGSC serves as a role model for individual scholarly development (continuing educational development at the graduate level).

The outside-in view is the learning (or students') view of the College. It contrasts sharply with the inside-out view because resources are of little concern. The central issue is the image the student has of CGSC and, in turn, the motivation this view provides. CGSC provides leadership to the Army in the development, practice, and preparation for warfighting.

Restatement of the Mission

In light of the above views and the goal of this study, it was necessary to interpret the CGSC mission statement and expand upon it. To this end, the following five mission requirements were identified:

1. Conduct individual training in warfighting at the tactical and operational levels and prepare officers of all services, including foreign officers, for their continuing careers in the profession of arms.

2. Develop combined arms doctrine to include the functions and procedures attendant to specific tactical and operational levels as prescribed in Field Manual FM 100-5, AirLand Battle (FM 100-5) (Hq. Dept. of the Army, 1976) as well as the knowledge structure and analytical framework required for the execution of such operations as prescribed in FM 101-5.

3. Develop collective training tools and techniques (potentially broadening its formally assigned mission) for the training and development of division, corps, and higher level headquarters in the tactical and operational levels of warfighting.

4. Distribute as widely as possible and provide the greatest possible access to the scholarly materials and resources of the College.

5. Be the center of excellence for Army doctrine development and the development of techniques for teaching higher cognitive skills (this statement is not supported by the previous discussion, but follows from the purpose of doing the study).

Command and Control (C^2), The Essence of CGSC

Definition of C^2

After examining the results of Task A, particularly with respect to the learning objectives and the consensus view that KSA are prescribed by FM 101-5, the project team felt that CGSC does, in fact, teach command and control. This idea was put forth at the Army Command and Control Concepts Study Conference and was supported by the officers present. This view is not in conflict with the notion the CGSC teaches warfighting but rather clarifies the relationship between FM 101-5 and the doctrinal how-to-fight manuals that include FM 100-5 and others.

Command and control is explained as the following:

> A human process bounded by a body of knowledge supported by mechanical systems and information processing.

This definition generally agrees with that of the Combined Arms Center representative during the conference (Task E). The key elements of the definition are as follows:

- the process,
- the body of knowledge, and
- the electronic system.

It is important to distinguish among them.

Command and control process is the <u>human</u> process by which decisions are made and subsequently executed. It involves human beings, their interactions, their judgments, and their emotions. Command and control, in the context used here, is not mechanistic but rather produces judgments made under circumstances of stress and fatigue. Within the Army, only one publication deals in depth with this human process that requires higher cognitive activity: FM 101-5.

The body of knowledge includes the doctrine contained in FM 100-5 and its related publications as well as the collective judgment or heuristics resident in the officer corps. It represents the facts and procedures that will greatly influence the outcome of the next battle. While the Army's doctrinal publications are prescriptive in nature, they are also descriptive as they represent the collective thought of the officer corps. For this reason, it is important to foster the outside-in view described earlier and encourage and maintain a dialog with those serving in the field.

Finally, there is the electronic system that supports the process. In the case of CGSC, the current focus is toward the MCS. However, the capabilities of electronic technology are doubling almost every three years. It is very unlikely that the MCS of today will be fielded as is. The electronic system is important but only incidental to command and control. It is the process

through which humans exercise judgment and make decisions in the application of tactical and operational doctrine that should be the concern of CGSC.

During the analysis of staff officer KSA conducted in Task B, a comparison was made to Fayol's management model (Kast and Rosenweig, 1979). This model depicts the management cycle as being a continuous loop of planning, organizing, coordinating, directing, and controlling. In contrast, four principal staff functions were identified: providing information, making estimates, making recommendations, and preparing plans and orders. These four functions roughly map to the first four steps in Fayol's model. That is, they support the command or decision making process.

Yet, as was noted in the findings of Task B, many of the tasks included under preparing plans and orders more clearly map to the management step of controlling, the same as in command and control. In reality, during execution of a plan, the commander delegates authority to his staff to act in his behalf within certain bounds. The intent of this observation is not to challenge the legal aspects of the term command but rather to highlight an area requiring further clarification.

Trends in Command and Control

During the Army Command and Control Concepts Study Conference, it was concluded that the decision making process and the procedures described in FM 101-5 will remain basically sound for the foreseeable future. However, the amount of information available will increase, while the time for the process to transpire will be abbreviated. The automation of field headquarters will continue, with the officer moving ever closer to the machine in the performance of his duties. These trends suggest two points with respect to CGSC.

- First, the automation of the field will have to be emulated in the classroom with sufficient fidelity for the student to practice and interpret staff and decision making tasks under similar temporal conditions, which does not mean that field equipment is required in the classroom. From a cost standpoint, such an approach seems unwise. Instead, an adaptable classroom system is needed that can simulate the field environment with adequate fidelity while maintaining a sound instructional underpinning.
- Second, a new set of heuristics, or old ones in new garb, will emerge to enable the selection of appropriate material for decision making. In fact, new decision heuristics may evolve. In this regard, BCTP and the ARI EDDIC (Experimental Development Demonstration and Integration Center) facility play a major role with regard to the doctrinal development process for command and control. Specifically with respect to BCTP, the difficulties it creates with regard to its collective training mission and the mission of the College are offset by its potential contribution to better doctrine.

Doctrine, Novices, and Experts

One way of looking at CGSC is through the doctrine that it develops, which provides the path for changing novices into experts. This statement is supported by cognitive science. Specifically, the field of cognitive psychology is currently having a significant impact on education and training methods, including not only format of training and content of lectures and exercises but also the organization and use of printed training materials. This impact is occurring because of recent research findings about how people think, solve problems, and learn new information (Calfee and Hedges, 1980; Schmeck, 1983). This research has been prompted, in part, by the discipline of AI. An essential component of most AI systems is the knowledge base, which must contain a representation of how experts solve problems in that particular domain.

Cognitive psychology methodologies are the tools used to extract expert knowledge representations. How does cognitive science relate to the work of the CGSC and, in particular, to the focus of this study? It relates to the instructional approaches recommended in computer opportunities, but it also relates to recommendations regarding use of the existing doctrinal manual on staff skills (FM 101-5) in the curricula.

Implicit in any manual or text is a conceptual model: a view of the knowledge organization of the particular domain (Norman, 1983). The conceptual model was invented, perhaps unconsciously, by the document's author(s). In contrast to the conceptual model is the mental model, which exists in the mind of an individual, and is created through interaction with a particular system or domain. The individual learner generates associations between prior learning and new stimuli; thus, the mental model is dynamic. Mental models can also be incomplete and/or inaccurate representations of the system. In cognitive psychology, much study has been devoted to comparing the mental model of the novice to the conceptual model of the expert and/or text.

The mental versus conceptual model approach is very useful in the study of the learning process and the building and implementation of instructional materials. As Whittrock (1977) states: "Cognitive theory implies that learning can be predicted and understood in terms of what the learners bring to the situation, how they relate the stimuli to their memories, and what they generate from their previous experience."

In the instructional process, one wants to ensure that the learner's mental model is evolving in the right direction. If the mental model adaptation and construction are left entirely up to the student, as they often are, mischunking of information occurs. This situation results in the learner's not being able to retrieve the right information at the right time at a later date during problem solving. Therefore, it is essential that the instructional materials have built into them an accurate conceptual model which is, if possible, explicitly related to the learner.

Figure 3 shows a model that relates FM 101-5 to the rest of the doctrinal material developed by CGSC. In short, the structure provided by FM 101-5 allows for the application of the facts and procedures contained in the other doctrinal publications. Additionally, the analytic procedures prescribed in FM 101-5 provide the basis for synthesis and evaluation (according to Bloom's Taxonomy) as they are practiced and internalized.

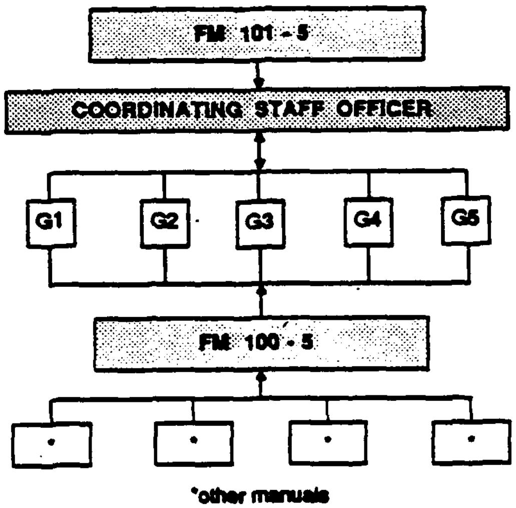

Fig. 3. Relationship of FM 101-5 to other doctrinal material.

A Learning Perspective

Figure 4 shows a graphic relating the transfer of training or learning to the vehicle of instruction. At the left is the conventional classroom characterized by lecture, text books, and tests. The training format with the greatest transfer value is desirable in an unconstrained world, but the realities of the world thrust cost directly into the picture.

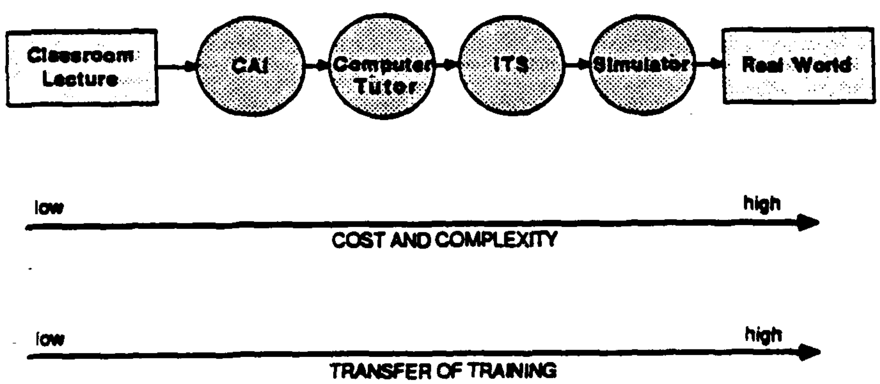

Fig. 4. Continuum of education/training.

Obviously, the techniques of the conventional classroom have proved themselves; they represent the formal education most of us have received. As was shown in Task A, much of the instruction at CGSC reflects the conventional classroom approach. Note that in this model, the 16-man class or staff group is included in the conventional classroom. In other words, size is not a determining factor in this model group, but the procedures followed in the classroom are determining factors.

The first circle on the chart includes CAI, which is a very broad category in itself and ranges from the presentation of programmed texts via computer to computer tutors (second circle) in which AI techniques are emulated to give the student the feeling of a personal tutor. Closely related is the third circle that represents intelligent tutoring systems (ITS) in which AI is used to diagnose and correct student misconceptions.

Following ITS is simulation (fourth circle) in which the real world is represented for the purpose of learning. Succeeding simulation is, of course, the real world. However, the real world for the military is war, making the use of a training tool with a lesser transfer value required.

The relationships among cost, transfer of learning, and the delivery system for training are not linear. In fact, they are quite complex and very much related to the specific subject matter. Also, in many instances, there may not be any empirical evidence to support a choice of one mode over another. Accordingly, no blanket recommendation for specific instructional formats can result from this study. However, as you can see from the next subsection of this report, some recommendations can be made in this area.

A Taxonomy for the Application of Computers to Learning (ACL)

Because this study was directed toward the use of computers at CGSC and its mission includes education (or training or learning), it was necessary to assess the opportunities for the use of computers to enhance the current curricula. Additionally, the KSA required of staff officers had to be evaluated from the perspective of how computers could be used to teach them. For consistency, they could be taught via standard taxonomy for categorizing ACL. In the process of constructing it, the results of Task C-1, reflecting the use of computers in other institutions of higher learning, were considered in the construction of the following taxonomy:

Applications of Computers to Learning

Administration: This application is for performing administrative functions, which might include record keeping, word processing, database management, course registration, and preparation and presentation of instructional materials.

Testing: This computer-managed instruction (CMI) function involves measurement via computerized tests of student retention of previously learned KSA.

Computer-Assisted Instruction (CAI): This application uses computer courseware for mastery learning of newly introduced KSA needed for basic task elements, for example, performing the administrative functions required by the tasks.

Simulations for Individual Training (SIT): This application involves training via computer that requires application and analysis of previously learned material. These instructional simulations model some aspect of reality with sufficient fidelity to present the student with situations requiring him to apply previously acquired KSA.

Intelligent Tutoring Systems (ITS): ITS, which involve AI, serve as tools for learning new KSA and practicing already acquired KSA through a continuous interaction with a program that diagnoses student misconceptions and clues correct action, based on an expert knowledge base and a student model.

Gaming: Concepts are applied and practiced through a computer game, generally of less fidelity than a simulation, that models a relevant subject area and requires exercising the concepts against a real or virtual opponent.

Simulations for Collective Training (SCT): KSA required of a team are practiced by a group in a simulation designed for presenting evolving situations that demand the application of the team KSA.

CAI, Games, and Simulations

The taxonomy distinguishes among CAI, games, and the different types of simulations. Many people might argue with this distinction, but it seemed necessary to distinguish among the many options available to CGSC. The complexity of ACL was discussed earlier in A Learning Perspective. The distinction between simulation and games as used here requires additional discussion. In essence, the difference relates to the intended use of the instructional approach, which is displayed in the following figure:

	GAMING	SIMULATION
Purpose	concepts	analysis
Prerequisites	fewer	more
Need to Understand the Model	yes, but can learn while playing	yes
Fidelity	not as critical	must be high

Fig. 5. A gaming vs. simulation matrix (adapted from the following reference).

An insight can be gained in the following quote from Chris Crawford (1986) in Balance of Power:

> Games and simulations are similar in that they attempt to represent reality, but they differ in the intentions of their designers. A simulation is a serious attempt to represent the operation of some system with a verisimilitude that the most knowledgeable experts on the system would find acceptable. A simulation is often created with the intention of predicting the behavior of the system under situations otherwise not obtainable.
>
> A game is dramatically different in its intentions. A game is to a simulation as a painting is to a blueprint. A painting of a house gives you an emotional impression of the house; a blueprint of the house tells the carpenter exactly where to put the windowsill. A game is no mere approximation of a simulation or a lower quality version of a simulation. Instead, a game focuses on presenting broader, less quantifiable concepts. One would not use a painting as a basis for building a house, nor would one use a blueprint to convey feelings about the house in which he spent his childhood. The difference is a matter of "soft concepts" versus "hard concepts"--those things that cannot be measured as opposed to those things that can.

Translating this perspective to the ACL taxonomy, some of the differences between games and simulations are displayed below.

TABLE VIII. Games and Simulations Versus Scope Versus Level of Detail

Type	Scope	Detail
Individual Simulations	Narrow (one staff position)	Higher
Games	Broad (in operational scope but narrow with respect to staff positions, for example, the G3)	Lower
Collective Simulation	Broad (entire staff)	Higher

Within Task B, only 4 of the total number of 182 of the KSA were identified as needing a collective simulation to effectively teach the task. Further, the status of collective simulations suggests that other approaches be pursued in the near- to mid-term. (See the standalone report Identification of Computer Opportunities.)

Figure 6 depicts the major elements of a simulation for collective training. Today, the link between the student group and the computer is through controllers, as is the representation of the opposing force. The controller overhead must be reduced if these simulations are to have application for repeated play. In this regard, many responses are occurring across the community.

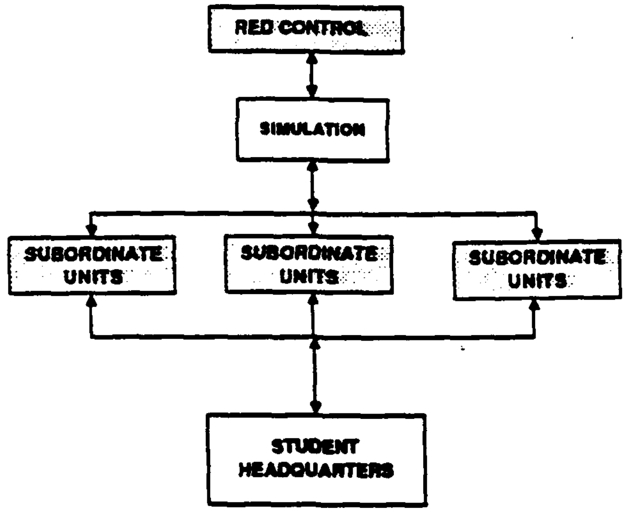

Fig. 6. Major elements of a simulation for collective training.

= CONTROLLERS

At the Los Alamos National Laboratory, work is progressing on a brigade planner that will interpret the division operation order and be the interface to the computer simulation. Using AI, this research effort holds great promise but is only nearing 30% completion. It may take another three to five years to complete the development and then additional time to adapt it to specific training environments (Morgeson, 1987).

At the Singer Company, Link Simulation Systems Division, work is underway to provide controllers with automated assistants so that they can concentrate on the role playing their positions demand. The R&D program is directed at using expert systems so that controllers (role players) can ". . . monitor, override when appropriate, and maintain a high degree of realism in the complex environments of command and control training." (See Pasewark, 1987). A Link subsidiary, Allen Corp., is also examining control functions in the joint exercise support system (JESS) to identify potential AI applications for reducing controller workload and to develop software specifications for the most promising candidates (Solick and Lussier, 1986).

As a final example, Perceptronics is developing intelligent opponent models for training tactical decision making. In this work being done for the Naval Training Systems Center, Perceptronics is using AI as the means to model the heuristic behavior of an opponent and to include planning as well as reaction to a situation. Again, it is emphasized that this is a research program (Madni, 1987).

The obvious conclusion with regard to simulations for collective training is that much remains to be done. It may be several years before reducing the controller overhead burden becomes a reality. BCTP is charged with monitoring the technology in this area as well as improving upon the simulations in use. Hence, for the rest of CGSC, appropriate planning would ensure that open ended architectures are adopted for any computer implementation so that collective simulations can be used as they become available. For the short term, CGSC should focus on individual simulations and games to achieve the instructional objectives, as appropriate.

The State of CGSC

Assessing the best route for a journey depends on the beginning and end points. In this project, the destination is constrained by how far the College can go and how quickly. In other words, the final destination of the journey is closely related to the state of CGSC today. Accordingly, a great deal of effort was focused on understanding the College, its organizational elements, the facilities available, and the directions in which it is going.

Computer Literacy

While the term "computer literacy" is very misleading and subject to much personal interpretation, understanding where the College stood was critical to assessing where to begin. Within the College there is a requirement for a minimum level of quality of instruction. Historically, this level of quality has been very high. The project team assumed that the quality level must remain high and that even minor perturbations to a lower level would be unacceptable. Hence, if computers are used in the classroom, instructors must have sufficient literacy to maintain the standard of instruction.

The low-risk approach to avoid compromising instructional quality influences the selection of ACL elements for implementation. For any computer application, the instructors/authors are critical to success. These individuals must use and augment the instructional systems as well as serve as the subject matter experts for their construction. At the same time, the students must accept and use the computer as a valid learning tool.

In the assessment of computer literacy, the project team found that CGSOC students were more literate than CAS^3 students who were more literate than the CGSC faculty. In each group, literacy ranged from no knowledge to advanced programming capabilities. SAMS, SPD, and SOCS students were not polled. The nature of the SAMS Course implied a higher level of literacy for these students. SPD students were felt to be of a lower priority in this study because of time and resource constraints. Finally, SOCS students are assumed to exhibit the same profile of computer literacy as resident students.

As stated above, the literacy assessment was made to identify where to begin. In this regard, the officer corps that comes in contact with CGSC must reach a common, minimal level of literacy (to be discussed below). Achieving this goal implies a change in the literacy profile. The faculty is the catalyst for such change but is the weakest group profiled in the literacy study. Hence, changing CGSC into an institution in which computers are a part of the learning process must begin with the faculty.

What level of literacy is required? Obviously, most officers are not and should not be expected to be computer programmers. However, the current direction of the Army suggests that officers will be required to <u>use</u> computers to perform certain tasks. Officers should be able to use the human-computer interface with sufficient skill to properly instruct the computer and interpret the computer's response.

The examination of computer literacy clearly showed that implementing ACL within CGSC must begin with the faculty. Yet more importantly, it demonstrated the need for carefully designing a single interface standard that permits all users to access, use, and understand all of the tools available. And, this standard must apply throughout the schools of the College.

Additional Influences on ACL in CGSC

The organizational elements of CGSC as well as other organizations resident at Fort Leavenworth are elements of a bureaucracy. It is emphasized that this is not a negative observation but rather underscores the organizational dynamic in which change must occur. Each element has its own mission to achieve within the scarce resources allocated to it. If the conflicts between the elements change from healthy to unhealthy for the organization as a whole, organizational change--including a redistribution of missions--is warranted. Because implementation of ACL has far reaching consequences, an examination of the organizational elements is essential.

Internal to the College. The Director of CAS^3 is singularly responsible for both the resident and nonresident instruction of CAS^3 students. Further, the resident and nonresident phases are linked, successful completion of the nonresident phase being a prerequisite for the resident phase. It should be noted, however, that CAS^3 does not have a major doctrine development mission because it deals with preparing officers for the transition from company-level to battalion- and brigade-level assignments. As such, the general cognitive level of the curriculum is the lowest of the CGSC schools. Finally, CAS^3 has been using calculators, and to an increasing extent computers, as tools for problem solving in the classroom.

SAMS is similar to CAS^3 in the purity of its instructional mission but differs markedly in the cognitive level of its curriculum. Also, SAMS students represent a significant resource with regard to doctrinal study, perhaps not fully tapped. Computer resources available to SAMS are mainly constrained by a lack of appropriate software to reduce controller overhead and facilitate study of battle dynamics.

SPD has a multiplicity of instructional missions keyed to many special purpose courses. It is heavily dependent on the other departments and centers for its instructor resources. While it might be useful and possible to streamline SPD's instructional responsibilities, examination of these possibilities was considered to be beyond the scope of this study. In general, SPD relies upon the availability of resources, knowledge, and personnel available in the rest of the College.

SOCS is the interface between the College and the officer corps at large. Currently, it has about 33,000 students enrolled. Yet SOCS is fully dependent upon the other schools and centers for its instructional materials, and its position in the College is unequal to that of other schools. With respect to CGSOC materials, SOCS lags in resident course content. Finally, SOCS has a tremendous overhead burden in the distribution of course materials while being manned substantially below its stated requirements. In sum, SOCS needs help. It is in the weakest state of all CGSC elements, yet it influences the greatest proportion of the officer corps.

CGSSdoes not exist as a formal organization. Instead, it is an amalgam of two centers, two departments, and an institute, the directors of which report to the Deputy Commandant. Each element has responsibility for doctrine development, resident instruction, and nonresident instruction. There is no individual solely responsible for CGSS.

In part, the problem of CGSS can be traced to the conflicting requirements for doctrine development and instruction. To enhance doctrine development and its importance, several elements exist within the College. In turn, these elements demand the prestige of reporting directly to the Deputy Commandant. If a CGSS were truly established, either the centers would be subordinate to the Director (CGSS perceived as undesirable), or a matrix organization would be created (currently not in vogue and a major departure from the traditional line and staff organization).

It is understood that while this study was underway, a parallel curriculum study was conducted internally by CGSC and that the current organization was reaffirmed. This decision is not challenged but is accepted as a statement of fact that the focal point for CGSS will remain the Deputy Commandant. However, in view of the substantial near-term challenges facing the College with respect to automation and the management of change, the College may want to consider creating a position for an Assistant Deputy Commandant solely responsible for CGSS as a schoolhouse, a "chief of staff" for this function. If the Secretary of the College were made responsible for the administrative/logistical functions (G1/G4), the Assistant Deputy Commandant could assist the Deputy Commandant in leading CGSS.

DACTS is the de facto center for automating the College with respect to ACL, but this element does not have the staff or resident skills to do the job. Implementing ACL requires both an advocate and central direction/coordination to bring together the many disparate initiatives currently underway as well as to efficiently manage future initiatives. As shown in the report on Task G, the opportunities to use automation as an "instructional force multiplier" are enormous, but unity of effort is required. A notional DACTS organization that would provide the necessary personnel and skills is shown in Fig. 7.

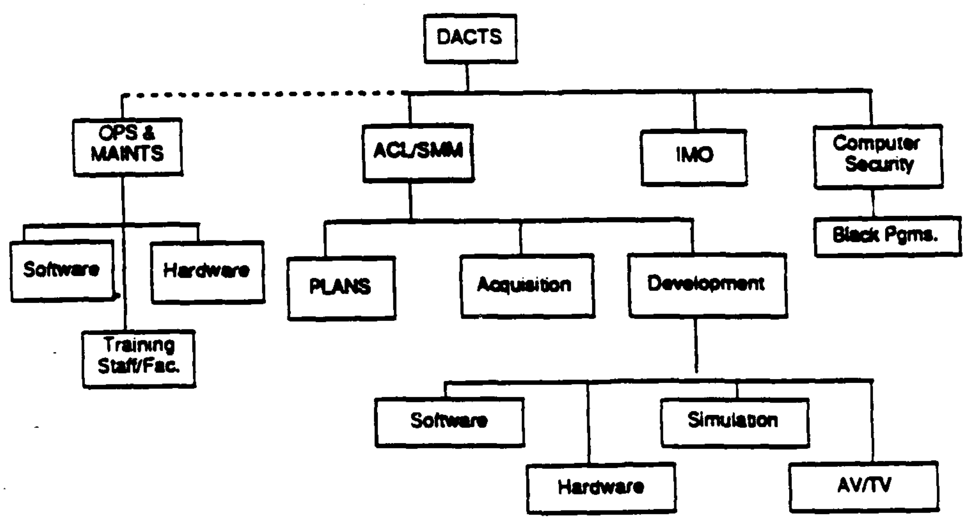

Fig. 7. Notional DACTS organization.

BCTP and Classroom 2 represent two initiatives that should be closely integrated into all of the CGSC curricula. While BCTP represents a collective training initiative, it has great potential for effectiveness in CGSC. Today, manual wargames are conducted within the CGSC schools as part of the individual training function. If done correctly, the BCTP simulations could greatly reduce the controller overhead required of CGSC exercises, thereby enhancing instructional efficiency. Likewise, Classroom 2 represents the link between the field and the classroom. If the functionality of MCS and ATCCS can be captured in the classroom, then CGSC can afford students the advantage of gaining "artificial experience" in battle control.

Both BCTP and Classroom 2 represent experiments, the results of which must be leveraged to the advantage of the College proportionally to the other institutional requirements. This point argues the necessity of a strong DACTS and singular responsibility for instruction in each school. Further, BCTP and Classroom 2 are training vehicles first and doctrinal tools second.

External to the College. Several organizations play important roles. First, the DOIM "... performs the Army's newest function, information management, for the U.S. Army garrison by providing integrated, sustaining base information management services and support to the installation." (See Comptroller of the Army, 1985.) According to the TRADOC supplemental guidance, the Information Center under the DOIM could be interpreted as satisfying the function of DACTS as suggested above. Such an interpretation, however, would seriously degrade the College's implementation of ACL. Implementing ACL requires bringing together several disciplines to stimulate the proper creative synergy. A listing of representatives from the disciplines required by the College environment follows.

Personnel Required for ACL Implementation

Subject Matter Experts	Computer Programmers
Instructional Designer	Networking Specialists
Script Writers	Database Management Specialists
Video Production Experts	Electronic Publishing Experts
Audio Production Experts	Managers
Computer Scientists	

These people are the ones who determine requirements based on the Army's operational environment, doctrinal advances, curricula requirements, and ACL technology. It is understood that ACL represents a specialized set of computer applications, generally unique to the College at Fort Leavenworth. Hence, a good relationship between the DOIM and the DACTS is imperative, each party doing what it does best: the DACTS, in conjunction with course matter experts, determines requirements through research and analysis, while the DOIM implements solutions to requirements.

The second external organization is Combined Arms Training Activity (CATA). By its charter, CATA could lay claim to BCTP because it is a collective training tool. CATA has proponency for the National Training Center (NTC) at Fort Irwin, CA. If an NTC East is established, as is frequently discussed with respect to BCTP, then CATA can be expected to have proponency for it. The significance of this point is that the format and role of BCTP is still emerging. If BCTP leaves the College, its use as a collective training tool will be ensured, but its contribution to the College's individual training mission could be weakened. If BCTP stays within the College, CGSC will become heavily committed to collective training, directly competing for individual training resources. The alternative solution may become two BCTP systems: one for use in collective training (under CATA) and one for use in support of the College's individual training. Adopting this alternative requires that BCTP be fully considered in automation and ACL planning.

Finally, there are many organizations and elements resident at Fort Leavenworth involved in command and control and computer modeling. Because the business of the College is, *inter alia*, command and control, close liaison among the participants at the technical level is essential. Again, the need for a strong DACTS is argued.

Computers At CGSC

An inventory of computer assets within the College is summarized in Table IX. Significant within the inventory was the multiplicity of systems on hand with no apparent standardization among systems. The lack of centralized control was evident and must be corrected if large-scale adoption of ACL is to become a reality.

TABLE IX. CGSC Baseline Computers (Approximate Distributions August 1987)

System	Staff	Faculty	Classroom/Student
Wang/Syntrex (WP)	11	26	2
Apple	8	7	12
Corvus	6	18	81
Hazeltine	11	18	13
Wyse	11	16	96
Other (Intel, IBM, Altos, Burroughs, TI Terminals, etc.)	9	9	100+

Two computer programs stood out in the review of computer assets: MAPP and COTES. MAPP represents a very fine effort on the part of individual officers to provide computer-based tools for CAS^3 students. MAPP illustrates the creative thought of the faculty with respect to computers that is critical to ACL. What MAPP lacks in software engineering and user interface design can be corrected by professional designers and engineers. However, these professionals could not have conceived MAPP, which had to come from the subject matter expert.

COTES, on the other hand, represents a product developed by a contractor to meet a specification and is delivered on an awkward, unfriendly machine. Conceptually, COTES is good, but it failed in implementation, primarily in the user interface.

Success of ACL in CGSC has two necessary conditions in the area of computers. First, hardware must be standardized, meaning having the same administrative systems across the departments and the same classroom systems across the schools. This approach does not preclude a Classroom 2 but instead addresses the broader, widespread applications of ACL and leads to the other necessary condition. Second, the user interface must be standard across the College and simple. This single point will contribute most to the success or failure of ACL implementation.

Facilities

The construction of the GIB and the renovation of Bell Hall offer the opportunity to achieve economy in supporting equipment for ACL. Specifically, the classroom configuration and network wiring can be part of the facilities' specifications.

While the greatest economy in installation can be achieved through a precise statement of equipment at this time, three points suggest that this approach would result in false economy. First, any requirement specified today will be obsolescent in five years. Second, specifying equipment to emulate Army command and control systems still under development is risky. The final point relates to the instructional format used within the classroom. While the staff group has been identified as the format of choice, exceptions may be required based on subject matter, instructor availability, or exercise requirements, to name a few. Hence, general specifications that permit easy installation and reconfiguration at a later date should be incorporated into the building requirements.

Another element of concern with regard to the GIB and Bell Hall relates to space allocation. The project team discovered evidence of planning for learning centers within CGSC facilities. Doubt remains that a sufficient number of learning centers will be provided.

A learning center is a facility where students can have access to computers during nonclass time and to a wide variety of software as required. Because purchase of a specified computer as a prerequisite for CGSC attendance is unrealistic, access must be provided through open facilities. The alternative is for the students to have after-duty-hours access to their classrooms. Because security is both better and easier to implement with the learning center, it is the preferred approach.

Baseline-Functional System Requirements

To fully implement ACL at CGSC, three requirements documents are needed. The first is the baseline document that identifies the status of the College today and projects its ideal future status. This planning process involves the functional requirements with regard to organizational and instructional issues and establishes priorities for the allocation of resources. It must identify what is to be taught, the opportunities within ACL, and the general or notional steps

required to achieve the desired goals. This study fulfills the requirement for establishing the baseline requirements subject to College review and approval.

Second, the functional document identifies functional requirements that must be satisfied to achieve the goal. The process of identifying these requirements involves the detailed itemization of what tasks must be accomplished to achieve the College mission. From these tasks, requirements for hardware, software, and courseware can be established at a "generic" level. For example, if a requirement for networking is supported, the purposes of the people who need to have access to the network are also identified. These requirements form the basis for establishing the system requirements.

With regard to the College and the use of computers in the classroom, a complete requirements specification for the use of computers in the classroom cannot be fully realized in the short term because the state-of-the-art with regard to ACL does not embrace the full spectrum of the ACL taxonomy, particularly with regard to simulation and gaming. Hence, the functional systems requirements document is a "living document" that will change with emerging technology, both in command and control and learning. However, recognizing the need for an open architecture that can adapt to change does permit development of functional requirements that allow the process to begin.

The final step, system requirements, represents the translation of functional requirements into technical hardware and software specifications. These specifications are then used for competitive procurements as required. It should be noted that some of these requirements may be for research to advance and validate techniques at the higher levels of the ACL taxonomy which, in turn, may modify or better define some functional requirements.

Costs and Benefits of ACL

No element of ACL should be implemented until there is reasonable assurance that the benefits will justify the costs, which does not mean that risks should not be taken to find out if a specific approach is worthwhile. Instead, many pilot programs must be tested to validate their effectiveness before a full-scale implementation is undertaken. With regard to the cognitive levels of the CGSC instructional material, most of it encompasses ACL elements that cannot be considered fully developed technologies. This section will consider each element of the taxonomy, noting its potential, the risks, the costs, and a terse assessment of what should be done. The reader is referred to a complete description of the taxonomy on page 46.

Administration

This element primarily concentrates on improving the efficiency of how the current learning process is administered. In the case of CGSC, this element also assists in improving doctrine development. A corollary benefit is development of an environment in which the computer becomes a commonly accepted tool and the users consider other uses for the tool. Both the hardware and the software are well established, making their acquisition and the training of users the primary expense.

Within the administration element, the College has many potential applications that collectively will move the CGSC into an automated world. These applications include the development and production of lesson materials and training aids; doctrine development to include research, data and information collection, and documentation (for example, writing the FMs); expanding College access to the officer corps; and generally easing the management functions. Further, administration represents the necessary first step to permit the development and implementation of higher elements of the taxonomy.

Implementing administration involves satisfying three requirements. First, standard personal computers with appropriate software suites need to be provided to most members of the staff and faculty. Implied in this step is the training of personnel to use the tools. In parallel with providing the tools, a standard interface must be developed that specifies how the software is presented to the user and how the user controls the software. This interface must allow for system growth. Notionally, it should follow the windowing approach developed by Xerox and seen as the strength of Apple's Macintosh. This approach is used by ARI in their EDDIC facility at Ft. Leavenworth.

Administration for students is similar to that of the staff and faculty because tools, such as word processing, are available to assist in homework preparation. Two things must be done to implement administration with regard to students. First, while it is unreasonable to provide each student with a computer, each student must have access to a computer and its tools. Following the lead of civilian universities, learning centers should be established in which computer/software systems are available for the students. This approach reduces the maintenance burden of supporting individual student computers but adds a requirement for student proctors and facility availability during nonduty hours. A corollary benefit is that the learning center can be used as a classroom for general computer training.

The second requirement for implementing administration for students is providing identical computer/software systems for student purchase. A range of low-end through full-up systems must be available to allow the student to work within his budget. Finally, the computer must be seen as having usefulness beyond attendance at CGSC. Of course, the purchase option should also be available to staff and faculty for home use.

The final aspect of administration is networking. Shown in Fig. 8 is a notional network for CGSC. This network represents baseline functional requirements that include:

- Faculty access to data and information bases for both instruction and doctrine development.
- Faculty communication with other faculty members and individuals at other service schools (E-mail, asynchronous conferencing, and data transfer).
- Student-faculty communication for homework and instruction/discussion, including asynchronous conferencing.
- Faculty and student administrative support.
- Student access to data and information bases.

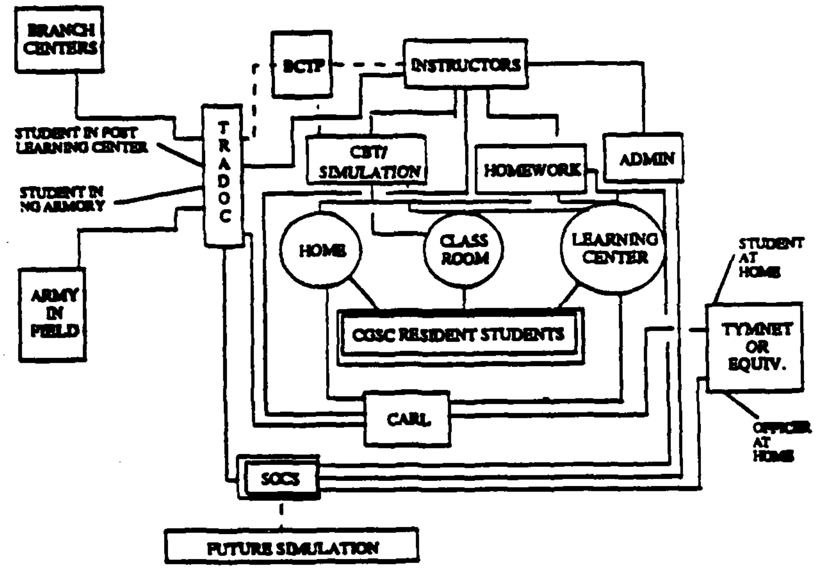

Fig. 8. Notional network for CGSC.

Initially, the network would support the E-mail concept and access to resources, such as CARL. Regarding CARL, both students and faculty should have remote access to the electronic card catalog and, eventually, abstracts and documents. The "homework" box in Fig. 8 represents a facility for faculty-student communication that includes an option for testing via written requirements, such as term papers and monographs. Note that resident student links include access from learning centers and quarters (a student option) as well as from the classroom. The classroom link represents a longer term expansion to support other ACL elements.

The final element of the network concerns SOCS students and the officer corps at large. Networking using established Army networks and commercial links, such as Tymnet, can significantly improve SOCS instruction. Initially, this system would provide student administrative support, access to the faculty by SOCS students through asynchronous conferencing, for example, and SOCS student access to CARL-type resources. Presentation of instruction via this network requires further study; however, the posting of changes to instructional material could be a near-term reality. This last aspect implies a distribution of study materials in electronic form, such as through CD ROM technology and electronic publishing.

SOCS has significant influence in developing some of the leaders of the "Total Army." This fact suggests that SOCS improvements should have the next priority for ACL initiatives, just behind staff and faculty support, which affects all CGSC responsibilities. The SOCS networking requirement also opens up CGSC to the entire officer corps, permitting broader participation in the doctrinal development process. This single step can enhance the outside-in view of CGSC by making it an electronic university of tactical and operational doctrine. No further study is needed on the question of its advisability.

Administration

Potential: Increased efficiency of staff, faculty, and students and opening CGSC to the officer corps on a continuing basis.

Risk: Minimal. Hardware and software are readily available except the standard interface. The biggest risk is in the selection process.

Costs: The estimated average cost of providing computers for administration is approximately $3,500 per staff or faculty member including training costs but excluding networking. Some special purpose systems and initial networking costs will also be incurred. Annual maintenance costs must be determined after system specifications are established but are estimated at 10% of the investment cost per year. For this function, student costs are estimated at approximately $3,500 per student for approximately 30% of the maximum resident student population to equip learning centers. After system specifications are established (automation of the library database), separate estimates must be made for CARL. Networking of SOCS to its student population requires development of systems specifications.

Action: Begin implementation of automated administration as soon as possible. This step supports both doctrine development and instruction and is a catalyst to initiate higher levels of ACL. As a development effort, enhance MAPP and COTES as part of the standard set of hardware and software for all users.

Testing

Testing in ACL offers the opportunity for some increased efficiency in the grading process, the ability to better analyze the instruction process through the automatic collation and assessment of test results, and the potential for situational testing, that is, the evaluation of an individual's skills when presented a "case" to solve in other than written form. How much learning will be directly improved through computer-based testing is questionable, but two applications hold near-term promise for usefulness: entrance or validation testing for CAS^3 and CGSOC and SOCS testing on-line with the previously described network. Automation of these tools coupled with immediate feedback in the form of a learning prescription should assist in the learning process because the graded response can be in real time. Finally, computing and testing techniques could be used for data collection in surveys, automating the tabulation of inputs as well as statistical number crunching.

Testing

Potential: Improved testing procedures for SOCS and for validation of skills upon arrival at CGSC. In the later case, results of the test could generate a remedial course of study, potentially also in computer form. In the case of normal CGSC instruction, the use of computers for testing other than electronic

grading does not appear efficient in the short term (necessary workstations will not be available until after the GIB and Bell Hall remodeling is complete). In the long term, it could be a valuable tool for evaluation as an adjunct to simulations for individual training. Finally, increased efficiency in surveying student/officer populations and reduced data collection time with nonresident officers are possibilities.

Risk: *Basically, a low-risk direction for SOCS and entrance testing.* Other applications need further study to determine impact and/or cost benefit.

Costs: Minimal for routine tests but higher for tests resulting in a learning prescription (greater design costs). Testing for limited programs, such as resident prerequisite programs, can commence as soon as learning centers are established. With regard to SOCS, testing is constrained by lack of the network.

Action: Very little at this time. This application depends upon the availability of the SOCS network and learning centers for near-term implementation. In the longer term, it is constrained by the availability of the "high-tech" classroom (to be discussed later).

Computer-Assisted Instruction

As defined in the taxonomy, this element provides for the teaching of skills related to basic task elements. When correlated to Bloom's Taxonomy, it generally aligns with the lower order cognitive elements even though some sophisticated applications at higher cognitive levels have been developed. For example, the Los Alamos Combat Unit Leader Trainer, a computer tutor, which focuses on higher order cognitive skills, in part, falls in this element of ACL and, in part, simulations for individual learning.

Assuming availability of a delivery system, costs for courseware for this element cover a wide spectrum. Usually, 1 hour of instruction is used as the basic element for gauging costs; the ratio of development time to course time ranges from 100 to 400 hours for 1 hour. That is, it takes 100 to 400 hours of development time to produce 1 hour of courseware. Further, labor charges for development personnel span a range of $20 to $90 per hour. The use of videodisc, digital audio, or other recent advances, such as CD ROM, adds additional costs. For example, production of a single videodisc will add an additional $30,000 to $100,000 to the development costs. Once courseware is produced, it is generally fixed; changes can be made only by the courseware developer. While minor changes could be accommodated (routine maintenance), major changes of content would require a new piece of courseware.

Ultimately, the value of this task element lies in its potential for repeated use. As an example, consider a 1-hour, mid-range courseware project versus classroom instruction in 16-man staff groups. Assume the courseware takes 200 hours to develop at $50 per hour for labor and uses 20% of a $30,000 videodisc, which equates to a $16,000 investment. Further, assume

that it is used for a CGSOC class of 1,000 students, resulting in a per student cost of $16 (note that for 1 year of CAS^3 students [4,000], the cost is $4 per student).

In contrast, an instructor's time at CGSC costs about $53 per hour, based on an annual cost of $100,000. Assuming 5 hours of preparation for the hour with the 16-member staff group, the cost per student is between $19 and $20. The live instructor cost is generally constant, even if one hour of instruction undergoes major revision from year to year. However, the electronic courseware costs per student per hour continually drop as the number of students goes up, yet the quality of instructor/computer-student interaction remains constant.

Courseware should be developed as a replacement for "live" instruction in cases where the course material deals with lower cognitive level KSA, the course content is not volatile, and the number of students that will use the material is sufficient to make the per student cost attractive. Remedial instruction for deficient, new students also is attractive because it is one of the less volatile content areas. Yet in both cases, the development of the courseware is dependent on the delivery system, which should have greater capabilities than a computer that supports administration (for example, videodisc, CD ROM, digital audio, and graphic overlays on video).

Another aspect of CAI is tools, such as MAPP and COTES, that are used incidentally to other classroom instruction. In a networked classroom, students can share work, and the instructor can monitor progress. Also, with computer overhead projection capabilities, any student or the instructor can present his solution instantly. While this is a nontraditional view of CAI, it highlights the point that learning with a computer's help is often more than a computer-student interaction.

A final aspect of CAI development is that hardware must be selected and specifications must be created for courseware design and development. The hardware will not be usable until facilities are available. Also, hardware issues remain to be resolved regarding the "high-tech" classroom, other ACL elements, and the Army's EIDS program. Further, if done correctly, resident courseware will be exportable through SOCS, thus making resident and nonresident instruction closer in content and quality. The negative aspect of this situation is that the availability of delivery equipment to nonresident students could unreasonably limit flexibility for resident instruction. Finally, the skills for courseware specification need to be developed within CGSC.

Computer-Assisted Instruction

Potential: Could replace portions of instructor-taught material and facilitate the export of training. Particularly useful for remedial training of nonvolatile course material.

Risk: Relatively low for lower cognitive level KSA because the technology is proven. For higher cognitive levels, the risk increases somewhat, and courseware should be validated before widespread use.

Costs: Courseware development tends to be the most costly part of this ACL element. Accordingly, the cost of hardware should not be allowed to limit future courseware options. Per hour software costs vary widely and are somewhat related to the cognitive level of the subject matter.

Action: Develop an exemplary prototype hour of courseware on a full-up delivery system that demonstrates every option available. A suggested topic is computer-assisted instruction itself, aimed at the faculty. The project should come under the purview of the DACTS. This project will permit the selection of media for future applications in time to influence requirements for the GIB and Bell Hall as well as develop in-house skills for the future. Additionally, pursue the continued development and improvement of MAPP and COTES for use as aids within the classroom. Finally, in Task G, potential applications have been identified by subject hour. These applications need further evaluation by CGSC personnel regarding volatility of content and longevity of the subject matter itself in the curricula.

Simulations for Individual Training

A degree more difficult than CAI, SIT in the CGSC context are part task trainers for the application and analysis cognitive levels. They are part task trainers because they are concerned with one staff position or a subset thereof. By themselves, these trainers do not teach all staff KSA at once.

These training tools must simulate the real world environment and emulate the tools the student will have available in the field (for example, MCS). However, while it is important to show the consequences of the student's decisions, the narrower scope of the instructional objectives permits some scenario control. Unfortunately, such simulations for CGSC are an undeveloped area and require research to define the parameters of design. Like CAI, however, the delivery systems will not be available for two or three years.

These simulations may have a beneficial link to BCTP as the BCTP simulation may be able to be tapped for the representation of consequences. In addition to the design issues of the interface to BCTP as well as uncertainty regarding the final BCTP form, questions of demand must be explored. It is possible that all CGSOC students (or CAS[3], SAMS, or SOCS students) could use SIT simultaneously. Under such circumstances, the computing power required could exceed the capacity of any reasonable machine. In the BCTP environment, many players are using one simulation. In SIT, each student requires his own simulation. The conclusion is that further study is needed to define the hardware and software requirements for SIT in CGSC.

Simulations for Individual Training

Potential: SIT promise to be mainstays for individual training at higher cognitive levels. However, much preliminary work needs to be done to increase SIT's probability of success. A major consideration is the conceptual base for using SIT as an instructional tool. This base will establish requirements for

concurrent use, computer demands, and software design parameters. Note that some applications of SIT could result in embedded training tools.

Risk: Embarking on extensive SIT development at this time would be a high-risk effort. Risk can be reduced by further study as indicated above and by the use of rapid prototyping for the user interface design.

Cost: Cannot be estimated at this time because they are directly dependent on simulation design and fidelity requirements. Initial investments, however, are likely to be greater than for computer-assisted instruction.

Action: Continue to develop requirements by examining course content with respect to specific KSA. Standalone reports on Tasks A, B, F, and G form the foundation for this development together with recent internal reviews conducted by CGSC.

Intelligent Tutoring Systems

ITS lie mainly in the research domain. As the technology develops, ITS could have many applications at CGSC even though few applications were identified in Task G. ITS use AI, which requires knowledge extraction to identify what needs to be represented. Command and control, the business of CGSC, is perhaps the most complicated domain in military thought. As such, the enormity of building ITS militates against any near-term applications.

Intelligent Tutoring Systems

Potential: Very high in the long term, but the technology is in its infancy, primarily existing in laboratory research programs.

Risk: Very high.

Cost: Very high based upon knowledge extraction requirements.

Action: Do not pursue ITS at this time.

Gaming

The difference between gaming and simulation has already been discussed on a conceptual level. But with regard to CGSC, a few additional differences need to be indicated. First, in comparison with simulations for collective training, gaming can be used by a single individual or a small group. The entire spectrum of pertinent detail is represented to allow the user to get an overview of what is happening. In this regard, gaming has significant usefulness in the SAMS environment, especially if a game can be developed with varying the resolution.

A second difference between gaming and simulations for collective training is the size of the machine needed to run it. Conceptually, games can be run on small machines, thus allowing many groups or individuals to play the game simultaneously. Also, games require less input from the uses. For example, in a G3 game emphasizing tactics, the other G-staff functions, as well as the opposing force, would be simulated by the computer. Gaming has great potential for use in the SAMS environment as the course emphasizes the tactical and operational art of war.

With respect to SIT, gaming deals with broader concepts and total functions. Clearly, gaming can supplement SIT. Nevertheless, gaming does not generate the detail required by SIT but does provide insight into a broader spectrum of functions. For example, a G3 SIT would deal with the details of the G3 functions themselves, while a G3 game would deal with tactical concepts and the relationship of the G3 with the rest of the staff.

The greatest potential for gaming deals with the control portion of command and control. As was shown in the assessment of staff officer KSA, this function is not clearly represented in FM 101-5, yet it exists in reality. Conventional instructional methods are difficult and awkward to use for teaching control because control deals with a continuously unfolding and changing situation. Gaming has the potential of making the teaching of control possible because gaming hits the middle ground of allowing each member of a group of students to see the big picture. SIT do not permit such individual insight because they are too focused, and simulations for collective training do not do it because they have too much detail, requiring most participants to focus on individual staff functions.

The negative aspect of gaming is that tactical games of the requisite detail have not been developed, and there is some question that they can be developed. However, the scale of gaming makes the financial risk much smaller than with major simulations. For example, the Balance of Power game referenced earlier was developed by Chris Crawford in about a one-year period. Hence, an attempt to develop a game is a submillion dollar risk, not unreasonable considering its potential for teaching the controlling function.

Gaming

> **Potential:** Very high. Probably the best choice for teaching control without using disjointed scenarios; and, therefore, it has high potential for showing the consequences of a decision.
>
> **Risk:** Moderate risk because tactical games have not been developed. The risk is moderated by the existence of business and political games.
>
> **Cost:** As a development effort, low. If the approach is sound and the design potential is established, further development cost would be small when compared to broad-scale use.

Action: Pursue gaming as a means to teaching control by investing at the research level. If gaming is a valid approach, its validity would be established at the same time that the classroom hardware becomes available.

Simulations for Collective Training

These simulations fit the mold of BCTP, that is, they provide the detail to and require the detail from an entire staff and its commander. SCT represents the ability to conduct a CPX (Command Post Exercise) with only one command post playing. Historically, the greatest limitation on SCT has been the controller overhead. While the BCTP program may lead to reduced overhead and/or greater fidelity, it is a collective training device.

Even though CGSC is concerned with individual training, BCTP still is exceptionally useful because at certain points in the curricula, large-scale exercises are scheduled. While the goal of these exercises is not team building, they are necessary to provide the CGSC student experience in the total, human staff context. Hence, a single tool can support both individual and collective training goals. Useful guidance for the development of SCT for use in CGSC classrooms can be found in the Solick and Lussier (1986) paper.

Simulations for Collective Training

Potential: High potential because SCT can reduce overhead requirements for large-scale simulations that develop individual skills. If the mission of CGSC is broadened to include collective training, these simulations become required.

Risk: The track record for SCT that provides sufficient fidelity at reduced controller overhead levels is poor. Hence, risk must be considered high despite enthusiasm of the design team. Once accomplished, however, improvements should come faster.

Cost: Generally, the demand for fidelity in detail requires these simulations to be run on larger computers (mini or greater) and requires more complex software both in design and in execution. The costs for developing each SCT are considered to be fairly high to high. Hence, near-term, widespread implementation of SCT within the College should be approached with caution.

Action: Monitor the BCTP program closely and explore means for interfacing the program to the College's classrooms. In view of the nature of the program, it may be more realistic to have resident students use BCTP in the facilities provided for it if time is available.

The High-Tech Classroom

In the above discussion, the high-tech classroom was mentioned several times with reference to a discussion to follow. The term does not refer to Classroom 2 of CGSC as it is currently being configured. What is envisioned by this term is a prototype classroom with the

latest developments in instructional technology. Eventually, CGSC classrooms would be based on this prototype. The notion includes the use of computers and other technical aids to instruction. A possible description of the high-tech classroom includes a workstation for every two students with a controlling station for the instructor. The student workstation would include two separate but interconnected computers allowing for data access and manipulation, command and control emulation, video, graphics, networking, and a simple-to-use human-computer interface. All workstations would be networked, allowing for the use of external tools. Also, the instructor station would have the ability to display the information on any screen in the classroom.

The details of this classroom remain to be established. At this point, the identification of constraints is underway. For example, the use of EIDS must be considered. Also, classroom emulation of field equipment is needed. The form that courseware will take will affect the types of equipment needed. In short, appropriate planning for the classroom of the future will result in facilities that will benefit from every advantage technology can provide.

PRIORITIES AND RECOMMENDATIONS

Priorities

In arriving at a set of recommendations, priorities must be established. In the case of CGSC, many factors enter into the assessment of priorities, reflecting judgments not only about what needs to be done but also about what can be done. Within CGSC, there are requirements for resident and nonresident instruction, doctrine development, and miscellaneous functions, such as the Military Review and hosting conferences. However, these miscellaneous functions are not inconsequential.

With regard to expanding the use of computers at CGSC, the project team recommends the following priorities among College responsibilities:

- Resident instruction (excluding collective training).
- Nonresident instruction.
- Doctrine development.
- Other CGSC activities related to distributing information (for example, Military Review).
- Collective training.

Collective training is assigned the lowest priority because it is not among the traditional CGSC missions, and the nature of the College's current association with BCTP may not be permanent. Also, having the lowest priority does not mean it should not be supported. Considering the high-level Army interest in BCTP, it will be supported whatever its impact on individual training.

The quality and content of resident instruction are better than those of nonresident instruction for a number of reasons, including the fact that the resident environment provides the stimulus for change and growth. Nevertheless, nonresident instruction affects the officer corps in general more than resident instruction. The current quality gap that exists between resident and nonresident instruction must be closed. As a single item, closing this gap should have a high priority.

Finally, doctrine development lags nonresident instruction because the doctrine has no value if no one knows what it is. This point, coupled with the quality lag between resident and nonresident instruction, demands that nonresident instruction be given the nod over doctrine development, at least until the gap is closed.

Recommendations

The following recommendations are made regarding the College in general:

- Establish the DACTS as the focal point for all College planning for the use of computers. Establish TDA positions by means of the organization depicted in Fig. 7. (Affects all priorities.)
- Enhance staff and faculty productivity and begin the automation of the College by providing personal computers with a standard software package. A recommended base hardware/software package is shown in Table X. (Affects all priorities.) (For a complete explanation of the considerations leading to these recommendations, see Task C-2 report [Assessment of Technology].)

TABLE X. Faculty Standard Personal Computer

Hardware	Software
Central Processing Unit (CPU) (80286);	Word Processor (WP) Lesson Development
Math Coprocessor (80287)	Communications
Random Access Memory (RAM) (640 K)	Graphics (View Graph)
Floppy Disc Drives (2)	Database Management (DBM)*
Hard Disc* Compact Disc Read Only Memory (CD ROM)	Spreadsheet*
Keyboard	
Mouse	
Color Monitor**	
Modem (1200 Baud Hayes Compatible)	
Printer	

*Special Applications - Limited Requirement
**Color required to fully use the capabilities of modern and emerging software.

- Supplement the standard PC with additional software and hardware as required for specific functions in specific organizational elements. For example, desktop publishing would be useful in many parts of the College but is not universally needed. (Affects all priorities.)
- Develop functional requirements for all near-term computerization initiatives to include networking, which encompasses both internal and external access as notionally shown in Fig. 8. (Affects all priorities.)
- Establish specifications for the human-computer interface that will be required for all software/courseware developed or acquired for College use. This task should parallel the development of functional requirements. (Affects all priorities.)
- Make the standard PC available for purchase. (Affects resident instruction and staff and faculty productivity.)

The following recommendations concern instruction and learning:

- Establish learning centers outfitted with the standard PC (Table XI). These systems must have potential for growth, being able to accept expansion units that permit other ACL implementations. Additionally, these centers must support staff and faculty training concurrent with the issue of PCs. (Primarily affects resident instruction.)

TABLE XI. Student Standard Personal Computer

Hardware	Software
(CPU) (80286); Math Coprocessor (80287)	WP
RAM (640 K)	Communications
Floppy Disc Drives (2)	Graphics
Hard Disc* (CD ROM ^)	DBM* ^
Keyboard	Spreadsheet*
Mouse ^	
Color Monitor**	
Modem (1200 Baud Hayes compatible) ^	
Printer ^	

*Special Applications
^ Indicates Options
**Color required to fully use the capabilities of modern and emerging software.

- Place emphasis on opening up CGSC to nonresident students and the officer corps in general through networking. Additional studies of the desirability of networking are not needed. SOCS specifications for implementing the "electronic university" should be developed now. Additional studies about SOCS after networking can continue. (Affects the outside-in view of the College and nonresident instruction.)
- Develop a CAI demonstration course that shows the state-of-the-art to the faculty and provides them with an appreciation of what can be done. (Primarily affects resident instruction.)
- Support research or request ARI to support research into gaming as it applies to the College. A successful game could be used as on-line by resident and nonresident students. SAMS should participate in the design process for the game. (Affects all students.)
- Begin planning for the "high-tech" classroom to include "one each" acquisitions for experimentation. (Affects resident students.)
- Establish a CGSS or identify a single assistant to the Deputy Commandant as responsible for the instructional content of the CGSOC, both resident and nonresident versions. (Affects CGSOC students by bringing resident and nonresident instruction closer in line.)

- Develop MAPP and COTES as conceptual or equivalent standalone tools for use on the standard PC shown in Tables IX and X. (Affects all students, assuming SOCS networking.)
- Conduct a periodic zero-base review of the curricula to validate the need for each lesson and identify factors affecting the stability of content. This recommendation also embraces a review of core versus elective courses in CGSOC because of the manpower devoted to maintaining so many electives. (Affects all.)
- Define the human-computer interface for use within CGSC.
- Initiate a courseware development program under DACTS. (Affects all ACL).

The following recommendation is made regarding doctrine:

- Control of operations, through an operations center and other means of staff supervision in conformance with command guidance, should be formally recognized as a fifth principal staff function ranking with providing information, making estimates, making recommendations, preparing plans, and others.

No recommendations are made with respect to BCTP because of the collective versus individual training quandary. However, as BCTP develops, every opportunity to exploit its capabilities for individual training should be seized. With regard to Classroom 2, the requirement for considering BCTP in all development efforts and as a major influence on the high-tech classroom seems to be implied.

REFERENCES

Bloom, B., Taxonomy of Educational Objectives: The Classification of Educational Goals, Handbook I: Cognitive Domain (Longman, Inc. New York, 1956).

Calfee, R.C. and L.V. Hedges, " Independent Process Analyses of Aptitude--Treatment Interactions," in Aptitude, Learning, and Instruction, R.E. Snow, P. Federico, and W.F. Montaque, Eds. (Lawrence Erlbaum Associates, Hillsdale, New Jersey, 1980), Vol. I, pp. 293-312.

Clancey, W.J., "Tutoring Rules for Guiding a Case Method Dialogue," in Intelligent Tutoring Systems, D. Sleeman and J.S. Brown, Eds. (Academic Press, New York, 1982).

Comptroller of the Army, Army Regulation 5-3, Installation Management, and Organization (Headquarters Department of the Army, Washington, DC, 10 November 1985) paragraphs 4-18.

Crawford, C., Balance of Power (Microsoft Press, Redmond, Washington, DC, 1986).

Headquarters Department of the Army, Operations, Field Manual 100-5 (U.S. Government Printing Office, Washington, DC, 1976).

Headquarters Department of the Army, Staff Organization and Operations, Field Manual 101-5 (U.S. Government Printing Office, Washington, DC, 1984).

Kast, F.E. and J.E. Rosenweig, Organization and Management (Mc-Graw-Hill Book Co., New York, 1979).

Madni, A.M., "Knowledge-Based Simulation: An Approach to Intelligent Opponent Modeling for Training Tactical Decisionmaking," in Interservice/ Industry Training Systems Conference, (Washington, DC, 1987), pp. 179-183.

Morgeson, J.D., Los Alamos National Laboratory, personal communication, July 1987.

Norman, D.A., "Some Observations on Mental Models," in Mental Modes, D. Gentner and A.L. Stevens, Eds. (Lawrence Erlbaum Associates, Hillsdale, New Jersey, 1983), pp.7-14.

Pasewark, G.J., "Application of Expert System Technology to Aid Controller/Role Players in a High Realism Environment," in Interservice/Industry Training Systems Conference, (Washington, DC, 1987), pp. 175-178.

REFLEX, THE ANALYST, 3rd ed. (Borland/Analytica Inc., Scotts Valley, California, 1985).

Schmeck, R.R., "Learning Styles of College Students," in Individual Differences in Cognition, R.F. Dillon and R.R. Schmeck, Eds. (Academic Press, New York, 1983), Vol. I, pp. 233-274.

Solick, R.E. and J.W. Lussier, "Design of Battle Simulations for Command and Staff Training," Army Research Institute draft technical report 788 (October 1986). (AD A195 655)

U.S. Army Combined Arms Center, Battle Command Training Program: Advanced Collective Training for Divisions and Corps (Leavenworth, Kansas) p. 2.

U.S. Army Command and General Staff College, United States Army Command and General Staff College Catalog (CGSC Circular 351-1) (U.S. Government Printing Office, Washington, DC, 1986).

Whittrock, M.C., "Learning as a Generative Process," in Learning and Instruction, M.C. Whittrock, Ed. (McCuthan Publishing Corp., Berkeley, California, 1977) pp. 621-31.